DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

TWENTY-FOURTH ANNUAL REPORT

OF THE

DIRECTOR

OF THE

UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

1902-3

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., October 12, 1903.

SIR: I have the honor to transmit herewith a report of the operations of the United States Geological Survey for the fiscal year 1902-3.

Thanking you for kindly advice and earnest support in the administration of the Bureau,

I am, with respect,

Your obedient servant,

Chas. D. Walcott,

Director.

Hon. E. A. HITCHCOCK,
Secretary of the Interior.

TWENTY-FOURTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

CHARLES D. WALCOTT, Director.

INTRODUCTION.

During the fiscal year 1902-3 the work of the Geological Survey, in geology, paleontology, geography, topography, forestry, chemistry, physics, hydrography, reclamation of arid lands, statistics of mining and mineral resources, etc., was carried forward on the basis established in former years and in accordance with the plan of operations approved by the Secretary of the Interior.

ORGANIZATION.

The increase of work, especially in the hydrographic branch, led to modification and extension of the scheme of organization, and necessarily to a considerable increase in the number of employees. Most of those appointed were hydrographers and engineers, selected by means of civil-service examinations for duty in the divisions of hydrography and reclamation service.

The following table exhibits the organization of the Survey at the close of the year:

Organization of the Geological Survey.

Branch.	Division.	Section.
Geologic	Geology and paleontology	Areal geology.
		Pleistocene geology.
		Pre-Cambrian and metamorphic geology.
		Petrology.
		Economic geology of metalliferous ores.
		Economic geology of nonmetalliferous minerals.
		Paleontology.
	Mining and mineral resources.	
	Physics and chemistry	Physics.
		Chemistry.
Topographic	Topography	Atlantic.
		Central.
		Rocky Mountain.
		Pacific.
		Triangulation and computing.
	Geography and forestry.	
Hydrographic	Hydrography	Eastern.
		Western.
	Hydrology	Eastern.
		Western.
	Reclamation service	16 arid States and Territories.
Publication	Editorial	Texts.
		Geologic maps.
		Topographic maps.
		Illustrations.
		Photography.
	Engraving and printing.	
Administrative	Executive	Correspondence and records.
		Supplies.
		Shipments.
		Documents.
		Instruments.
	Disbursements and accounts.	
	Library.	

RECLAMATION SERVICE AND GENERAL HYDROGRAPHY.

In the report for last year there was given a brief history of the effort to place on a satisfactory basis the scientific examination and development of the arid lands

of the United States, an effort which resulted in the passage of the Reclamation Act, approved on June 17, 1902, which sets aside the proceeds of the sales of public lands as a fund to be used in the construction of reservoirs and large canals. The Secretary of the Interior, who is charged by the law with the general administration of the reclamation work, intrusted the examinations, surveys, and construction of works to the Director of the Geological Survey, thus utilizing fully the experience and knowledge gained by this Bureau during the many years it has conducted similar investigations. Congress having also doubled the appropriation for the work of the division of hydrography, it was deemed wise to create in the Survey, for administrative purposes, a hydrographic branch. This branch was placed in immediate charge of Mr. Frederick H. Newell, who as a member of the Survey had been conducting hydrographic investigations for a number of years. An account of the operations of this branch, in reclamation investigation and general hydrography, will be found on pages 180–235.

OBITUARY.

Near the close of the fiscal year the Geological Survey lost by death a most valued member, Mr. Richard Urquhart Goode, one of its chief geographers. For a sketch of his life and work see pages 287–290. The death of Maj. J. W. Powell, for many years Director of the Survey, also occurred within the year. An account of his life and work is given on pages 271–287 of this report.

PLAN OF OPERATIONS.

The plan of operations for the fiscal year 1902–3 was laid before the Secretary of the Interior on July 1, 1902, and was approved by him the same day. This detailed plan is on file in the Department. The work of the year, hereinafter reviewed, was executed in conformity with the plan submitted and approved.

APPROPRIATIONS.

For and during the fiscal year 1902–3 there was appropriated for the work of the United States Geological

Survey the sum of $1,377,470. The acts making the appropriations set apart separate amounts for specific branches of work and for the salaries of persons connected with these branches. For convenience of reference these separate appropriations are here brought together and classified.

The legislative, executive, and judicial act contained the following item:

For rent	$28,400

The sundry civil act included the following items:

For salaries of Director, chief clerk, chief disbursing clerk, librarian, and photographer, together with clerks, messengers, watchmen, et al		$32,390
For pay of skilled laborers, etc		20,000
For topographic surveys	$300,000	
For pay of 2 geographers and 2 topographers	9,200	
Total for topographic work		309,200
For geologic surveys	150,000	
For pay of 4 geologists	13,700	
Total for geologic work		163,700
For paleontologic researches	10,000	
For pay of 2 paleontologists	4,000	
Total for paleontologic work		14,000
For chemical and physical researches	20,000	
For pay of 1 chemist	3,000	
Total for chemical work		23,000
For gaging streams, etc		200,000
For preparation of illustrations		18,280
For preparation of report on mineral resources		50,000
For purchase of books and distribution of documents		6,000
For engraving and printing maps		100,000
For survey of the forest reserves		130,000

There was appropriated in the same act for engraving, printing, and binding publications of the Geological Survey $215,000, this sum to be disbursed not by the Geological Survey but by the Public Printer. The items are as follows:

For engraving illustrations for report of Director and for monographs, professional papers, bulletins, water-supply papers, and report on mineral resources	$65,000	
For printing and binding report of Director, monographs, professional papers, bulletins, water-supply papers, and report on mineral resources	150,000	
Total for printing and engraving		$215,000

The deficiency act approved February 14, 1902, contained the following item:

For general investigations in Alaska	$60,000

The deficiency act approved March 3, 1903, contained the following items:

Installation of electric system, engraving division	$6,000	
Safe, for division of accounts	1,200	
Preparation of illustrations	300	
		$7,500
Grand total		1,377,470

ALLOTMENTS.

ALLOTMENTS TO GEOLOGIC WORK.

The total appropriation for geologic work for the fiscal year 1902–3 was $163,700, which was allotted as follows:

Allotments to geologic parties.

Party, etc.	Amount.
Executive office	$11,680
Adams, G. I. (Arkansas, Oklahoma, Texas)	3,700
Becker, George F. (California)	4,000
Boutwell, J. M., and Irving, J. D. (Utah)	5,100
Branner, J. C. (California)	350
Campbell, M. R. (Pennsylvania, New York, Kentucky, Indiana, Ohio, West Virginia)	9,800
Chamberlin, T. C. (northern and eastern United States)	8,000
Clark, W. B. (Maryland)	1,000
Cross, Whitman (Hawaiian Islands)	4,200
Dale, T. Nelson (Vermont)	1,250
Darton, N. H. (Nebraska, Wyoming, Montana)	1,500
Diller, J. S. (California)	6,600
Eldridge, George H. (California, Florida)	3,300
Emerson, B. K. (Massachusetts)	500
Emmons, S. F. (Colorado)	5,500
Fenneman, N. M. (Colorado)	350
Gilbert, G. K. (Nevada, Utah, New York)	4,000
Girty, George H. (Michigan, Arkansas, Texas, Indian Territory, Kansas)	2,500
Hague, Arnold (Yellowstone National Park)	2,000
Hayes, C. W. (Georgia, Ohio, and general administration)	7,700
Hill, R. T. (Texas)	5,000
Jaggar, T. A. (Massachusetts, Arizona)	1,600
Keith, Arthur (Tennessee, North Carolina, South Carolina, Georgia)	4,100
Kemp, J. F. (New York)	150
Knight, W. C. (Wyoming)	350

Allotments to geologic parties—Continued.

Party, etc.	Amount.
Lawson, A. C. (California)	$110
Lindgren, Waldemar (Arizona, California)	3,150
Osborn, H. F. (monograph on Ceratopsia)	2,100
Prosser, C. S. (Ohio)	300
Ransome, F. L. (Arizona)	5,400
Reid, H. F. (earthquake records)	125
Smith, George Otis (Washington, Maine)	5,300
Smith, W. S. T. (Kentucky, Missouri)	4,200
Spencer, A. C. (Wyoming)	4,100
Spurr, J. E. (Nevada)	3,000
Stose, George W. (Pennsylvania, map editing)	2,300
Taff, J. A. (Indian Territory)	4,200
Tarr, R. S. (New York)	100
Ulrich, E. O. (Kentucky, Arkansas, Indian Territory, Texas, Ohio)	2,000
Van Hise, C. R. (Michigan, Minnesota, Connecticut)	9,400
Vaughan, T. Wayland (report on fossil corals)	2,150
Walcott, Charles D. (general administration)	1,500
Weed, W. H. (Montana)	3,000
Weeks, F. B. (bibliography of North American geology)	1,800
White, David (West Virginia, Ohio, Pennsylvania, Indian Territory, Maine)	2,500
Williams, Henry S. (Pennsylvania, New York, Maine, Connecticut)	3,000
Willis, Bailey (areal and stratigraphic geology)	5,000
Wolff, J. E. (Vermont, New Jersey)	700
Contingent fund	4,035
Total	163,700

ALLOTMENTS TO PALEONTOLOGIC WORK.

The total appropriation for paleontologic work for 1902–3 was $14,000, which was allotted as follows:

Allotments to paleontologic work.

Party.	Amount.
Dall, William H	$2,650
Knowlton, F. H	2,100
Osborn, H. F	2,500
Stanton, T. W	2,600
Ward, Lester F	3,150
Contingent fund	1,000
Total	14,000

ALLOTMENTS TO TOPOGRAPHIC WORK.

The sum appropriated for topographic surveys was $300,000. Besides this general appropriation, certain stated salaries, aggregating $9,200, were appropriated for men engaged in topographic work, making the total appropriation for topography $309,200, which was allotted as follows:

Allotments to topographic work.

Section, etc.	Amount.
Atlantic section	$109,400.00
Central section	79,835.48
Rocky Mountain section	45,000.00
Pacific section	39,500.00
Purchase and repair of instruments	11,000.00
Office and contingent expenses	24,464.52
Total	309,200.00

ALLOTMENTS TO FORESTRY WORK.

The appropriation for the survey and investigation of forest reserves was $130,000, which was allotted as follows:

Allotments to forestry work.

Section, etc.	Amount.
Rocky Mountain section of topography	$43,300
Pacific section of topography	50,000
Economic examination of forest regions	20,000
Purchase and repair of instruments	3,000
Office and contingent expenses	13,700
Total	130,000

MISCELLANEOUS ALLOTMENTS.

Chemistry and physics.

For pay of all persons connected with the chemical and physical work, and for the purchase of supplies, apparatus, etc., the entire appropriation of $20,000 was allotted.

Mineral resources.

The entire appropriation for the preparation of the report on mineral resources, $50,000, was allotted to the gathering and compilation of statistical data for the calendar year 1902 and to the preparation of a report thereon, which is in press.

Engraving and printing maps, etc.

The appropriations for engraving and printing maps, purchase of books and distribution of documents, preparation of illustrations, pay of skilled laborers, etc., and the special appropriations, were expended for the specific purposes named in the act.

WORK OF THE YEAR.

FIELD AND OFFICE WORK BY THE DIRECTOR.

The general administrative work of the Survey occupied the greater part of the Director's time. In connection with the reclamation of arid lands, as provided for in the act approved June 17, 1902, he made an extended investigation of the proposed irrigation developments in Montana, Wyoming, and Nevada during August and September, 1902. In the spring of 1903 six weeks were given to an examination of the proposed irrigation developments in Arizona, especially with reference to the construction of the Tonto dam on Salt River and the utilization of storage waters in the vicinity of Phœnix.

In the office micrographic study of Cambrian faunas was continued.

The Director was assisted by Mrs. J. K. Gawler, confidential clerk, and many others of the Survey, as occasion required. Miss Elvira Wood was appointed private secretary to the Director on February 2, and continued in that capacity until the close of the year.

GEOLOGIC BRANCH.

Division of geology and paleontology.

ADMINISTRATION.

The organization of the division of geology and paleontology remained essentially as described in the last annual report; i. e., the administration was in the hands of the geologist in charge of geology, Mr. C. W. Hayes, while scientific supervision rested with the chiefs of sections. In addition to the sections enumerated in the last report, a new one was created during the year—a section of petrology. For several years past matters relating to this subject have been referred to a committee. It was decided, however, that more efficient and economical supervision could be obtained through the organization of a section, which was effected by an order issued January 7, 1903. Mr. Whitman Cross, formerly chairman of the petrographic committee, was designated as geologist in charge of the section. The petrographic reference collection, which consists of carefully selected type rock specimens from all regions that have been examined by Survey geologists, and is intended to aid geologists in their petrographic studies, has been brought to its present state of excellence largely through the efforts of Mr. Cross, and it remains under his charge, with added facilities for its improvement. The petrographic laboratory is also placed under his immediate supervision. This laboratory has, since its establishment, been in charge of Mr. J. S. Diller, and under his careful management has reached a high state of efficiency. Both for the quality of its work and for the rapidity with which the work is executed this laboratory probably has no equal. The highly specialized and technical character of petrologic investigations renders it especially important that reports bearing on the subject should be subjected to exceptionally careful scrutiny before publication. The responsibility for such critical examination now rests with the geologist in charge of the section of petrology.

The organization of the division of geology and paleontology is as follows:

Section of areal geology, Bailey Willis in charge.

Section of Pleistocene geology, T. C. Chamberlin in charge.

Section of pre-Cambrian and metamorphic geology, C. R. Van Hise in charge.

Section of petrology, Whitman Cross in charge.

Section of economic geology of metalliferous ores, S. F. Emmons in charge.

Section of economic geology of nonmetalliferous minerals, C. W. Hayes in charge.

Section of paleontology, T. W. Stanton in charge.

For several years the division of geology has cooperated with the division of hydrography in the investigation of questions relating to the geologic occurrence of underground waters. During the last year the hydrographer in charge has been able to devote a larger amount of money to this subject than heretofore, and several geologists have therefore been transferred to the hydrographic branch and assigned to a newly created division of hydrology, while others have been appointed expressly for this work from eligible lists of the Civil Service Commission. In its administrative relations this division is connected exclusively with the hydrographic branch, but the scientific supervision of its work, in so far as it is strictly geologic, rests with the geologists in charge of the various sections in the division of geology and paleontology.

With the increasing importance of the purely economic work being carried on by the Survey there is a growing demand on the part of mining men for prompt publication of results. To meet this demand and to place the results in the most accessible form possible, there was published early in the calendar year 1903 a bulletin (No. 213) entitled "Contributions to Economic Geology, 1902." It contains 61 contributions from 33 members of the Survey, and includes three classes of papers: (1) Preliminary statements of the results of extended economic investigations, which will later be described in more detailed form; (2) descriptions of phenomena of economic inter-

est noted in the course of field work, but not of sufficient importance to warrant separate publication; (3) abstracts of some of the more important papers which had appeared in Survey publications during the preceding year. The bulletin was prepared under the immediate supervision of the geologist in charge of geology, the compiling and editing being efficiently done by Mr. E. C. Eckel, assistant geologist.

STATE COOPERATION.

In addition to the sums appropriated for geology and paleontology ($163,700 and $14,000), there were available for work of the division during the year the following sums appropriated by various States for cooperation: Pennsylvania, $5,000; Maryland, $1,000; Kentucky, $1,833; New York, $400. The conditions under which this cooperation with the various States is undertaken have been fully explained in former reports. They have continued to give entire satisfaction to all parties concerned, and several other States are considering the desirability of securing cooperation with the Survey for geologic work.

NOMENCLATURE AND CLASSIFICATION FOR THE GEOLOGIC ATLAS OF THE UNITED STATES.

INTRODUCTION.

In January, 1889, the Director of the Survey, Maj. J. W. Powell, assembled the geologists of the Survey for a conference on the plan to be adopted for the Geologic Atlas of the United States. The questions submitted to their consideration covered the unit and scope of publication, the principles of the classification and nomenclature of rocks, the selection of certain units of a time scale, and the main features of a system of map notation. The discussions and action of this conference, and the subsequent action of the Director, produced a body of rules (Tenth Annual Report, pp. 63 to 79) under which the work on the Geologic Atlas has since been prosecuted. These rules, representing the results of much experience,

study, and experimentation, have stood well the practical test, and justified the care with which they were prepared. But the art of the geologist, as well as his science, is progressive, and the experience of fourteen years has naturally led to the modification of opinions. It finally became desirable to reconsider several of the adopted rules, and as the regulations constitute a coherent system a review of the entire subject was determined on.

The plan of this review was so arranged that the Survey might profit by the advice of all members of the corps engaged in field or laboratory work contributory to the atlas, but the duty of making a special study of the subject and of formulating a new code of regulations was assigned to a special committee. The members of this committee were G. K. Gilbert (chairman), W. B. Clark, Whitman Cross, C. W. Hayes, T. W. Stanton, H. S. Williams, and Bailey Willis, and near the close of its work C. R. Van Hise was added. Mr. F. B. Weeks attended to the preliminary correspondence and subsequently acted as secretary to the committee. A circular letter, dated January 10, 1902, was sent to geologists and paleontologists, asking them to examine the published rules and to submit in writing any suggestions for amendment which might occur to them. The body of suggestions thus obtained was submitted to the committee, which held a series of meetings in February and June, 1902, and then presented a preliminary report, including a preliminary or tentative draft of proposed rules. Copies of this tentative draft were sent to the geologists and paleontologists, and once more their opinions were invited. With the criticisms and suggestions thus obtained the committee resumed its work in February, 1903, holding a series of meetings, reconsidering all parts of the code of rules, and preparing a final draft. That draft, after revision by the Director, was promulgated in March, as a code of regulations for the making of the Geologic Atlas of the United States. The rules are as follows (paragraph 21 was added recently):

RULES.

1. There shall be recognized for cartographic purposes and for use in the maps published by the Geological Survey three great classes of rocks, viz: (a) *Sedimentary*, including all rocks formed by aqueous, organic, glacial, and eolian agencies; (b) *igneous*, including all rocks that have been solidified from a molten condition, both volcanic and plutonic; (c) *metamorphic*, including altered rocks of either sedimentary or igneous origin in which the acquired are more prominent than the original characteristics, together with ancient schists and gneisses of uncertain origin. There may also be recognized in the legend of the maps unclassified deposits, such as talus, landslides, veins, etc., which may not fall within the above-enumerated genetic classes.

2. In all classes of rocks the cartographic units shall be called formations.

SEDIMENTARY FORMATIONS.

3. The discrimination of sedimentary formations shall be based upon the local sequence of the rocks, lines of separation being drawn at points in the stratigraphic column where lithologic characters change or where there are breaks in the continuity of sedimentation or other evidences of important geologic events. It will be impossible to delineate on maps of the scale selected for the atlas sheets the limits of each lithologic change, and the geologist must select for the limitation of formations such horizons of change as will best express the geologic development and structure of the region and will give to the formations the greatest practicable unity of constitution. In determining this unity of constitution, all available lines of evidence, including paleontology, shall be considered. Each formation shall contain between its upper and lower limits either rocks of uniform character or rocks more or less uniformly varied in character, as, for example, a rapid alternation of shale and limestone. When the passage from one kind of rock to another is gradual it will sometimes be necessary to separate two contiguous formations by an arbitrary line. When two formations of closely similar lithologic character are in contact it will sometimes be necessary to depend almost entirely on the contained fossils in separating them. The selection of formations shall be such that they will best meet the practical and scientific needs of the users of the map. In every case the definition of a formation in the folio text should include a statement of the important facts which led to its discrimination and of the characteristics by which it may be identified in the field, whether by geologist or layman.

4. As uniform conditions of deposition were local as well as temporary, it is to be assumed that each formation is limited in horizontal extent. The formation should be recognized and should be called by the same name as far as it can be traced and identified by means of its lithologic character, its stratigraphic association, and its contained fossils.

5. When, for scientific or economic reasons, it is desirable to recognize and map one or more specially developed parts of a varied formation, such parts shall be called *members*, if they have considerable geographic extent; or if their distribution is more limited they shall be described in some appropriate term, such as *lentil*.

6. All sedimentary formations shall receive distinctive designations. The most desirable names are binomial, the first part being geographic and the other lithologic (e. g., Dakota sandstone, Trenton limestone, etc.). The geographic term should be the name of a river, town, or other natural or artificial feature at or near which the formation is typically developed. Names consisting of two words should be avoided. Names taken from natural features are generally preferable, because less changeable than those of towns or political divisions. When the formation consists of beds differing in character, so that no single lithologic term is applicable, the word "formation" should be substituted for the lithologic term (e. g., Rockwood formation). Members and other subdivisions shall be named in the same manner, but in the legend of the map the term "member," etc., shall always be added to the geographic and lithologic designation (e. g., in the Pottsville formation, the Homewood sandstone member).

7. In the application of names to members, formations, and larger aggregates of strata, the law of priority shall generally be observed, but a name that has become well established in use shall not be displaced by a term not well known merely on account of priority. In general, a newly defined formation shall not receive a name that has been previously used in a different sense.

IGNEOUS FORMATIONS.

8. The discrimination of cartographic units among the igneous rocks of any region is desirable in order to represent three kinds of facts: (1) *The mode of occurrence*, as lava flows, stocks, dikes, laccoliths, etc. Relations of occurrence not sufficiently expressed by the represented boundaries on the map should be concisely explained in the legend. (2) *The chemical composition of the rocks*, which is primarily indicative of plutonic or magmatic conditions and is expressed in the nomenclature of the rocks. By this means the constant or varying chemical character of the magmas erupted at different times from one vent, and the similarity or contrast of those erupted in widely distinct periods, or in different areas, may be recognized. (3) *The mineral and textural characters of the rocks*, factors controlled in part by the chemical composition of the magma, but in part influenced by local conditions of consolidation. While all the petrographic divisions founded upon the various characters can not in many cases be represented upon maps, it is permissible and desirable to discriminate all rocks whose characters render them locally notable or of economic importance. Since rules can not be laid down to cover the

details of such matters, the geologist is expected to exercise his judgment as to what is desirable in each case.

9. The name by which an igneous rock is designated upon the map may consist of two parts: (1) The petrographic designation, (2) a local term. The petrographic term should be one comparatively well known, as, for instance, the group term granite, basalt, trachyte, etc. The more technical systematic designations may be given in the descriptions of the folio text under the general term used in the legend. Technical terms may be used in the legend where no well-known group term is available.

10. The local importance of igneous masses often renders the use of geographic terms in connection with the petrographic names highly advantageous. By this means not only the different masses of one rock may be designated, but petrographic differences may be emphasized without recourse to technical names; e. g., Butte granite, and Bluebird granite. Such local names for masses of small lateral extent are not subject to the laws of priority and restriction prescribed for sedimentary formations.

METAMORPHIC FORMATIONS.

11. Cartographic units among metamphoric rocks of unknown origin should be discriminated upon the basis of their petrographic characters. Where masses of approximately uniform character are large enough for representation they should be distinguished. When a complex of schists, gneisses, etc., changes rapidly in character from place to place the cartographic units must be chosen to express groups with common characteristics.

12. When part of an igneous or sedimentary mass has been greatly changed in character, the limits between the greatly changed and the comparatively unchanged portions should be expressed.

13. Where two or more adjacent formations are metamorphosed, the formations should be discriminated throughout the metamorphic area when practicable.

CORRELATION AND GROUPING OF SEDIMENTARY FORMATIONS.

14. The fundamental data of geologic history are (1) the local sequences of formations and (2) the chronologic equivalences of formations in different provinces. Through correlation all formations are referred to a general time scale, of which the units are periods. The formations made during a period are collectively designated a system.

15. For purposes of general correlation formations shall be referred to the standard systems of common usage. Beginning with the latest the systems recognized are as follows: Quaternary, Tertiary, Cretaceous, Jurassic, Triassic, Carboniferous, Devonian, Silurian, Ordovician, Cambrian, Algonkian, and Archean. In most cases the definition and limits of the systems are determined primarily by paleon-

tology and secondarily by structural and stratigraphic relations. The exceptions are the Quaternary, the Algonkian, and the Archean. The criteria for the definition and limitation of the Quaternary system are primarily genetic, secondarily lithologic, structural, physiographic, and paleontologic. The characters by which the Algonkian and Archean are discriminated are lithologic and structural.

16. In various parts of the world, below the Cambrian, and usually separated from that system by an unconformity, is a great system of rocks to which can be applied the ordinary methods of stratigraphy. This system consists dominantly of rocks deposited under substantially the same physical conditions as those which obtained during the Cambrian and later periods. That is, these rocks are chiefly shales, sandstones, and limestones, and their metamorphosed equivalents. Associated with this system of rocks, both as intrusives and extrusives, are igneous rocks, precisely as is the case with the later systems. In some regions this older system is represented by two or more series, separated by unconformities. While scanty fossils have been found in a few areas, as yet they have not been discovered so distributed and in such abundance as to serve the purposes of correlation of the series from province to province. This system is named the Algonkian.

17. Below the Algonkian, and separated from it by a profound unconformity in the majority of regions, is another system of rocks of a radically different character. This system consists dominantly of schists and gneisses, the chemical composition of which, so far as tested, corresponds with igneous rocks rather than with sedimentary rocks. The lithologic variations of these schists and gneisses are exceedingly complex. Usually accompanying this lithologic complexity is exceeding intricacy of structure. In this matter of unparalleled intricacy of structure the system is unique. Many masses of igneous rocks belonging to later systems are intrusive in the ancient schists and gneisses. In various parts of the world minor masses of metamorphosed sediments are intimately associated with the remainder of the system. To this lowest system the term Archean is applied.

18. In the classification of a formation, when paleontologic evidence is lacking or inconclusive, leaving doubt as to the system to which the formation belongs, it shall be referred to some one system, according to the preponderance of all available evidence, and the doubt as to the reference shall be indicated. When paleontologic evidence shows that a formation is actually transitional between two systems, its transitional character shall be indicated; but when the evidence available is sufficient to determine the limits of the two systems, the boundary between them shall be mapped.

19. Systemic names may be used in combination where the facts of geologic development show continuity of events from one system to another. When the age of a formation or series is indeterminate it

may be indicated by using the prefix *pre*, or *post*, in connection with the name which designates the age of the nearest related formation, series, or system of known age.

20. Within the systems smaller aggregates of formations may be recognized, which shall be called *series*, and these may be divided into subordinate *groups* of formations. Groups may also be constituted without the recognition of series. These minor aggregates should be formed so as to express the natural relations of the formations of the particular province rather than to conform with divisions recognized elsewhere, though they may often prove to have a wider distribution.

21. In the naming of a newly constituted aggregate a geographic term should be chosen which has not previously been applied to a formation or aggregate; except (1) that the rank of a name may be changed without changing its stratigraphic inclusion, and (2) that the redefinition of an aggregate does not necessarily render renaming advisable.

22. The following series are now recognized as applicable to North America: In the Quaternary, Recent and Pleistocene; in the Tertiary, Pliocene, Miocene, Oligocene, and Eocene; in the Carboniferous, Permian, Pennsylvanian, and Mississippian; in the Cambrian, Saratogan, Acadian, and Georgian. In the other systems subdivisions of the rank of series may be temporarily distinguished as upper and lower, or upper, middle, and lower, as each case may require; or, when different provinces show a distinct development, provincial names may be used for series and groups. For example: In the Gulf province the lower Cretaceous is called the Comanche series, which is made up of the Washita, Fredericksburg, and Trinity groups, each consisting of several formations, while in the Pacific province the lower Cretaceous has a different development, both lithologically and faunally, and is called the Shasta series. The boundaries of the natural provinces which may be recognized for the purpose of defining provincial series and groups, and within which accurate detailed correlation should be practicable, will not necessarily coincide for the different systems.

23. In the preparation of the geologic atlas sheets the areal distribution of the formations shall be represented by suitable notation in the body of the map, and the notation shall show also the classification of the formations into systems.

24. A legend accompanying the map shall employ the same notation and indicate the names of the formations, together with their classification into systems, and, whenever practicable, their more definite correlation, either by reference to established series and groups or to upper, middle, or lower portions of the respective systems. The presence of erosion intervals and unconformities may be indicated in the legend of the map.

DETAILED STATEMENT OF GEOLOGIC AND PALEONTOLOGIC WORK.

WORK OF GEOLOGISTS IN CHARGE OF SECTIONS.

Section of areal geology.—Mr. Bailey Willis, geologist in charge, has been engaged throughout the year in work which falls into three classes: (1) Editing manuscripts for geologic folios; (2) supervision of and cooperation in investigations in areal and stratigraphic geology, including both field work and review of manuscripts; and (3) original research.

Twenty-two manuscripts for geologic folio texts have been read and passed. During April and May he was assisted in this work by Mr. H. F. Bain. Mr. Willis also examined numerous manuscripts pertaining to areal and stratigraphic geology submitted during the fiscal year, and conferred with the authors in regard to their preparation. During September, October, and part of November he was engaged in field work with Mr. George I. Adams in northern Arkansas, with reference to the stratigraphy of Paleozoic formations in the vicinity of Eureka Springs, Harrison, and Yellville; and, also with Mr. Adams, in northern Texas, with reference to the classification of the Red Beds, the Upper Carboniferous, and Permian strata; with Mr. C. N. Gould in a reconnaissance of the Wichita Mountains and the Red Beds and gypsum deposits of Oklahoma; and with Mr. W. S. T. Smith, at Joplin, Mo., in regard to an investigation of zinc deposits. The trip into the Wichita Mountains was projected in part for an investigation of reservoir sites and conditions of irrigation, upon which a report was made to the division of hydrography.

In original research Mr. Willis continued the preparation of a report on the physiography and deformation of a part of the Cascade Range, Washington, which was submitted in June, 1903, for publication as a professional paper. He also prepared a brief study of the physiographic features of Ames Knob, North Haven, Me., bearing on the submergence of that district, and compiled portions of the New York folio text. During the winter he prepared a series of paleogeographic maps of North

America at different geologic periods, as data for the proposed geologic map of the United States.

In March Mr. Willis received a grant from the Carnegie Institution for geologic exploration in eastern Asia, and was granted leave of absence for one year.

Section of Pleistocene geology.—Prof. T. C. Chamberlin, geologist in charge, was occupied throughout the year chiefly in the supervision of the work of the section. Besides the organization and direction of field parties, he spent considerable time in the examination of referred manuscripts relating particularly to Pleistocene geology. Under his direction Pleistocene studies were made in Michigan (Leverett and Taylor parties), Indiana (Leverett party), Massachusetts, New York, and Vermont (Taylor party), Wisconsin (Alden party), Utah (Atwood and Peterson parties), Montana (Calhoun party), and Wyoming (Salisbury-Blackwelder party).

Section of pre-Cambrian and metamorphic geology.—Prof. C. R. Van Hise continued in charge of this section, devoting a large part of his time to its supervision, both in the field and in the office. The early part of the field season was spent in the Eastern States, where critical localities in Pennsylvania, New Jersey, Connecticut, and Massachusetts were visited and studied with Prof. Florence Bascom, Prof. J. E. Wolff, Prof. Wm. H. Hobbs, and Prof. B. K. Emerson. The larger part of the summer was given to general structural work in the Lake Superior region, for the purpose of obtaining data for the closing monograph on that region. This work necessitated rather extensive studies in the original Huronian area.

In the office, aside from routine work, Professor Van Hise gave his entire time to the completion of a treatise on metamorphism, to be published as a monograph of the Survey. This treatise, besides covering the subject of metamorphism in its strict sense, contains chapters on the relations of metamorphism to stratigraphy, to ore deposits, and to the redistribution of the chemical elements.

The proof of the monograph on the Vermilion iron-bearing district of Minnesota, which was prepared last year under Professor Van Hise's supervision, was read by Mr. J. Morgan Clements.

Section of petrology.—This section was organized January 7, 1903, with Mr. Whitman Cross as geologist in charge. It is designed to unify the control of petrologic research in the Survey and to provide a head for such work who may be held responsible for results which will be creditable to the Survey. The field of supervision of the head of this section is geographically coextensive with the operations of the Survey, and relates to all parties engaged in petrologic work. His opinion is authoritative in matters under his supervision, and his approval of petrologic parts of all reports will be required before publication. It is expected that the chief of this section will effect such exchange of information and opinion with the geologists carrying on petrologic work as will give the results the highest practical scientific value and justify his approval on a basis of definite knowledge of field and office work.

The petrographic reference collection and the petrographic laboratory, being adjuncts of the section of petrology, are now under Mr. Cross's supervision. The petrographic laboratory was found to be in excellent condition, owing largely to the careful supervision by Mr. J. S. Diller, who had been in charge since its establishment. The immediate work in the laboratory is now, as formerly, conducted by Mr. F. C. Ohm, who is assisted regularly by Mr. William O. Ohm, and at times by Mr. W. S. Robbins. The latter has also rendered efficient service in the care of the petrographic reference collection. During the year 4,711 thin sections were made in the petrographic laboratory; 325 specimens were cut, 779 saw cuts were made, and 69 surfaces were ground and polished.

Section of economic geology of metalliferous ores.—Mr. S. F. Emmons, geologist in charge, spent the greater part of the month of July with Mr. J. D. Irving in an

examination of recent underground workings in the Leadville, Colo., district, particularly in the Ibex mine, the Yak tunnel, and in the mines immediately beneath the city streets, the so-called "downtown district," whose future constitutes one of the most important problems of the region. When the Yak tunnel is connected with the deep workings of the Ibex mine there will be exposed an underground rock section about 2 miles in length and in great part at a depth of more than 1,000 feet below the surface. Mr. Emmons desires to obtain full data with regard to this section before publishing his report.

On leaving Leadville, early in August, Mr. Irving proceeded to Park City, Utah, to join Mr. J. M. Boutwell in an economic study of that district, while Mr. Emmons made a reconnaissance examination of the Bassick mine, in Custer County, Colo., where a new shaft had recently been sunk in the volcanic agglomerate to a greater depth than had previously been reached, which it was thought might afford important data bearing upon the origin of ore deposits.

Afterwards Mr. Emmons inspected the iron mines at Hartville, Wyo., with a view to determining the general geologic relations. He then joined Mr. Spencer's party in the Encampment Mountains of Wyoming, and spent ten days in studying the geology and ore deposits of that region, of which he made a reconnaissance examination when geologist of the Fortieth Parallel Survey, in 1872. From there he returned to Laramie by way of the New Rambler mine, in the Medicine Bow Range, which has a remarkable body of copper ore carrying platinum. Unfortunately, the deeper workings of the mine were inaccessible at the time, and the ore deposits could not be satisfactorily studied.

Several weeks were then spent with Messrs. Boutwell and Irving at Park City, Utah, in an economic survey of that important and flourishing mining district. As this is the first piece of detailed geologic work in the Wasatch Mountains that has been undertaken by the section of

economic geology, it involves a consideration of the general structure of the entire range, with which Mr. Emmons is more or less familiar from his examination of it in 1869, while a member of the Fortieth Parallel Survey. The ore deposits in this district present a peculiarly difficult study, because of their dependence upon different phases in the geologic history of the range, which has been a remarkably long and complicated one. It has therefore been thought best to carry on the preliminary geologic mapping of the district with great deliberation and detail, as any error in this work might vitiate the conclusions to be drawn later from the ore deposits themselves and as it will serve as a final basis for all future work in the region. Hence it was decided that it was inadvisable to try to complete the work in a single summer, especially as the great altitude of the district renders the season for field work unusually short.

In the early part of September Mr. Emmons arranged with Mr. Spurr, who had been prevented by illness from taking the field earlier, to undertake a special study of the new and important gold-mining district at Tonopah, Nev. This work was commenced the latter part of October, after Mr. Spurr had assisted Mr. Spencer in bringing to completion the field work in the Encampment region, a district the study of which was originally assigned to him. It will require part of another season to complete the field work in the Tonopah district.

Mr. Emmons also kept in touch during the summer, by correspondence, with a special survey in the district of Bisbee, Ariz., which was being carried on by Mr. F. L. Ransome, assisted by Mr. J. Morgan Clements and Mr. Alfred M. Rock, and with the special examination of the Butte copper mines of Montana being conducted by Mr. W. H. Weed.

During the months of October and November Mr. Emmons was abroad on leave of absence. After December he devoted a very considerable part of his time to duties of an administrative nature, such as service on

committees, correspondence, critical reading of manuscripts submitted for publication, and, more especially, to contributions to and arrangement of Bulletin No. 213, on the economic geologic work of the Survey for the year 1902. The report on the economic geology of the northern Black Hills, by Mr. Irving and himself, was also completed and submitted for publication. The preparation of the Leadville report, which had been delayed by the absence of Mr. Irving, who had charge of the preparation of the maps and sections, and who had accepted the position of acting professor of geology at the University of Wyoming, was taken up in June.

Section of economic geology of nonmetalliferous minerals.—Mr. C. W. Hayes, geologist in charge, was occupied the greater part of the time throughout the year with his administrative duties as geologist in charge of the division of geology and paleontology. Some time was spent in the revision of a report prepared by Messrs. Hayes and Kennedy on the oil fields of the Texas-Louisiana Gulf Coastal Plain, published as Bulletin No. 212. Some time was also occupied in the revision and proof reading of the Columbia (Tennesse) geologic folio.

The policy of preparing reports summarizing information regarding various nonmetalliferous mineral products was continued during the year by the completion of a report by Prof. Heinrich Ries on the clay resources of the United States east of the Mississippi River.

In cooperation with the division of mining and mineral resources a report was prepared on the gypsum deposits of the United States, by Mr. George I. Adams, with the assistance of numerous specialists throughout the country, who contributed chapters on the several States.

One of the most rapidly growing mineral industries in this country is the cement industry. In response to numerous requests for information regarding the present development and future possibilities of this industry, a systematic investigation of its geologic relations was begun, and will be completed during the next year. The work

is being done by Mr. E. C. Eckel under Mr. Hayes's supervision.

Section of paleontology.—Mr. T. W. Stanton, paleontologist in charge, spent the months of July, August, and September in field work in northern California. From July 4 until August 14 he was engaged in cooperative field work with Mr. J. S. Diller, chiefly in the Redding quadrangle, Shasta County, where Jurassic, Triassic, Carboniferous, and Devonian rocks are well developed. A study was made of the stratigraphy of the rocks in the northeast quarter of the Redding quadrangle, including all of the stratigraphic column represented except the lower part of the Devonian. Full collections of fossils were made, of which those from the Jurassic and Triassic especially will be of great value in future stratigraphic and areal work on the western coast.

From August 15 until September 3 Mr. Stanton, with Mr. Diller and Mr. James Storrs, made a reconnaissance in the Klamath Mountains, in Shasta and Trinity counties, westward from Redding, to determine the age of certain limestones and other rocks in that region, as well as to obtain a general knowledge of the geology, all of which was in the main successfully accomplished.

Upon returning from this reconnaissance, Mr. Stanton left Mr. Diller's party and spent several days in further study of the Triassic as exposed on Cedar Creek, south of the area previously studied. Another brief excursion was made from Red Bluff to the Cold Fork of Cottonwood Creek, to study and collect fossils from the Cretaceous section there, with special reference to some reported plant-bearing horizons.

Office and laboratory work included administrative and other routine duties, such as identification of and reports on numerous fossil collections sent in by members of the Survey and others, service on committees, the review of referred manuscripts, etc., all of which consumed considerable time. The large collections obtained in California were worked over in a preliminary way, and the stratigraphic results were communicated to Mr. Diller for

immediate use. The manuscript of a monograph entitled "Pseudoceratites of the Cretaceous," by the late Prof. Alpheus Hyatt, was revised and submitted for publication during the winter, and in the spring proof of the same was read and corrected. Two brief papers were prepared for publication, one entitled "The Stratigraphic Position of the Judith River Beds," published in Science, and the other, "A New Fresh-Water Molluscan Faunule from the Cretaceous of Montana," to be published in the Proceedings of the American Philosophical Society. Such time as could be spared from other duties was devoted to work on a monograph on the Lower Cretaceous faunas of the Texan region, on which some progress was made in the description of species and the preparation of illustrations. It is estimated that three or four months of continuous work will probably be sufficient to complete it.

On June 1, 1903, field work was resumed, in cooperation with Mr. J. B. Hatcher, in northern Montana, beginning at Havre, the object being to determine accurately the stratigraphic position of the various vertebrate-bearing beds in the Cretaceous of that region, special attention being given to the Judith River and the Belly River beds.

Mr. T. E. Williard continued efficient work as a general assistant in the paleontologic section, unpacking, preparing, and caring for the large collections of fossil plants and vertebrates. During June Mr. Williard collected fossil plants for Mr. David White in the coal fields of West Virginia and Pennsylvania.

In April and May Mr. Stephen Bowers, of Los Angeles, Cal., was employed for thirty days in examining and collecting from the Upper Cretaceous exposures in the Santa Ana Mountains, in southern California.

WORK OF GEOLOGIC AND PALEONTOLOGIC PARTIES.

Adams party.—Mr. George I. Adams, assisted by Prof. A. H. Purdue and Mr. Ernest F. Burchard, was occupied during the months of July, August, and September in the survey of the northern Arkansas lead and zinc district. In connection with this survey, and with the assistance of

Mr. E. O. Ulrich, the Paleozoic section of northern Arkansas was reviewed and correlated.

During October Mr. Adams made a reconnaissance in Oklahoma and northern Texas, for the purpose of determining the stratigraphic relations of the Red Beds to the Carboniferous.

The reports on these surveys were completed during the winter; also a bulletin on the gypsum deposits of the United States.

From the middle of April until the middle of May Mr. Adams assisted Mr. J. E. Spurr in completing the survey of the areal geology at Tonopah, Nev., and later made an examination of the sulphur mines near Humboldt House, Nev. On June 12 he resumed areal work in northern Arkansas.

Alden party.—Under the direction of Professor Chamberlin, Mr. William C. Alden last year continued his studies of the Pleistocene formation of southeastern Wisconsin and the mapping of the quadrangles in that region. The results of this work, which includes the mapping of the rock formations underlying the drift and the study of the conditions of water supply and other economic features, are being prepared for publication as folios of the Geologic Atlas. In addition to office and supplementary field work on the quadrangles previously surveyed, the mapping of the Stoughton, Evansville, and Madison quadrangles was completed. From July 1 until July 23 Mr. Alden was assisted in field work by Messrs. W. H. Emmons and Frank W. De Wolf, voluntary assistants, and from September 1 until September 20 by Messrs. Eli Gale and Ray Johnson, in a similar capacity.

During the winter Mr. Alden prepared a paper entitled "The Darien Lobe of the Lake Michigan Glacier of the Late Wisconsin Stage of Glaciation and Attendant Phenomena." This manuscript, which deals with the relations of the glaciers of southeastern Wisconsin and northeastern Illinois, will be published as a professional paper of the Survey. Considerable work was also done

on the manuscript for the Janesville folio, covering the Janesville, Brodhead, Stoughton, and Evansville quadrangles, while the manuscript for the Burlington-Racine folio, covering the Bayview, Racine, Muskego, Silver Lake, Eagle, and Geneva quadrangles, was carried nearly to completion

Ashley party.—Under the supervision of Mr. M. R. Campbell the months of July, August, and September were spent by Mr. George H. Ashley and Mr. L. C. Glenn in field work in southeastern Kentucky. A study was made of the coal resources of the headwaters of Cumberland River in Bell and Harlan counties, and a preliminary report on the results was prepared by Mr. Ashley. Some progress also was made in the preparation of a detailed report, but the coal field was found to warrant the making of a better base map than was available, and the report will not be completed until after additional field work, based on the new map, has been done. Cross sections for the study of the stratigraphy were prepared by Mr. Glenn, and preliminary sketch maps and coal sections of much of the area were drawn by Mr. Ashley.

This work was done under an agreement for cooperation with the curator of the State geological department of Kentucky, Mr. C. J. Norwood. By the terms of this agreement one-half of the field and office expenses of the work was borne by the State organization.

Atwood party.—Under the direction of Professor Chamberlin, Mr. W. W. Atwood spent three months of the summer of 1902 in the study and mapping of the glacial features of the Wasatch and Uinta mountains. The work of the previous year among the Wasatch Mountains included in the Salt Lake quadrangle was completed; also that on the western half of the Uinta Range, included in the Coalville and Hayden Peak quadrangles. A preliminary study of the glacial features of the eastern half of the Uinta Range was made, and it is hoped that during the coming field season that work also may be completed. As every canyon heading at the crest of the range has

been glaciated, and as the records in these canyons indicate that there were at least two distinct epochs of glaciation, the work involves a careful study of the whole high-altitude area of the Uinta Range.

Bain party.—On April 1 Mr. H. Foster Bain was assigned to regular work with the Survey. Until May 11 he assisted Mr. Bailey Willis in his work as editor of geologic folios, and on the latter date left for the field to take up the systematic study of the lead and zinc deposits of the Mississippi Valley. A month was spent in studying the disseminated lead ores of the southeastern portion of Missouri, in cooperation with State Geologist E. R. Buckley and his assistants. In June Mr. Bain went to southern Illinois to study the zinc, lead, and fluorspar deposits of Pope, Hardin, and adjacent counties. It is expected that his work will be extended to the other mineral districts of the Mississippi Valley, with a view to the preparation of a report on the genesis, mode of occurrence, and economic importance of the ores of the entire region. This work will be pushed as rapidly as the geologic mapping now being carried on in that section will permit.

Bascom party.—Prof. Florence Bascom was engaged, under the supervision of Professor Van Hise, in field and office work on the Philadelphia special folio, embracing the Norristown, Germantown, Chester, and Philadelphia 15-minute quadrangles; in reconnaissance examination of adjoining regions, for the purpose of investigating the relations of the Philadelphia belt of crystalline formations; and in the detailed areal mapping of the West Chester 15-minute quadrangle. It is expected that the Philadelphia special folio will be completed and submitted for publication during the coming year.

Bayley party.—Prof. W. S. Bayley spent the entire year in office work, in the preparation of the manuscript for a monograph on the Menominee iron-bearing district of Michigan. This is the sixth and final report on the great iron-ore districts of the Lake Superior region. The manuscript was completed and transmitted for publication.

In June, Professor Bayley, assisted by Laurence La Forge, assistant geologist, began the study of the pre-Cambrian areas in New Jersey for the preparation of the Raritan folio.

Boutwell-Irving party.—On July 24 Mr. J. M. Boutwell began the investigation of the areal and economic geology of the Park City (Utah) mining district and vicinity. Mr. J. D. Irving joined him on August 8, after finishing field work at Leadville, Colo., and under the supervision of Mr. S. F. Emmons they were engaged for the remainder of the season in a detailed geologic survey of the Park City region. Data were obtained for a considerable portion of a special geologic map of the entire district and for a large-scale geologic map of the area around the principal mines, and reconnaissances were made of the larger mines. During a short visit by Mr. Emmons the broad geologic relations of the area and the general economic problems involved were considered, and a brief reconnaissance to Little Cottonwood Canyon was made for the purpose of comparative studies.

Extensive masses of igneous rock along the main divide of the Wasatch, around the heads of Big Cottonwood and Little Cottonwood canyons, were proved to be of intrusive origin and in date not earlier than Upper Carboniferous. Here valuable ore bodies of three genetically distinct types occur in sediments of Upper and Lower Carboniferous age. A fauna collected from the upper portion of the section—Permian or Mesozoic—has been found to differ from any yet described in this country.

During a reconnaissance of the Coalville quadrangle, Mr. Boutwell, with the assistance of Mr. Ellsworth Huntington, determined the general geologic structure and stratigraphic succession of that region, and obtained evidence bearing on the date and character of the Wasatch and Uinta uplifts. Previous observations as to the extent and time of great volcanic flows and the occurrence and age of valuable coal beds were corroborated. An occurrence of high-grade hematitic iron ore in limestone of Lower Carboniferous age in the Uinta Mountains was

studied, and data were obtained of occurrences of lead, silver, and copper.

After snowfall at Park City Mr. Boutwell and Mr. Irving turned their attention to the preparation of mine maps for use in detailed underground studies of the economic geology of the region. On November 17 Mr. Irving returned to Washington, and subsequently accepted the position of acting professor of geology in the University of Wyoming. Mr. Boutwell completed the underground maps on December 8, and proceeded to Bingham, where he finished studying the auriferous gravels, and afterwards investigated the occurrence and exploitation of the extensive deposits of rock gypsum near Nephi, Utah, and the general geologic structure of the Wasatch in that southern section, closing his field work and returning to Washington December 20.

During the winter Mr. Irving devoted as much time as he could spare from his university duties to the study and preparation of the material obtained for the Survey. He completed a report on the economic resources of the northern Black Hills, to which Mr. Emmons contributed a chapter on the Homestake mine and Mr. T. A. Jaggar one on the areal geology, and which has been transmitted for publication as a professional paper. He also completed the description of the economic geology for a double folio of the Sturgis and Spearfish (South Dakota) quadrangles and made progress in the study and preparation of the material for the Leadville report, devoting the whole of the month of June to that work.

Mr. Boutwell was occupied during the office season chiefly in completing his portion of the report on the areal and economic geology of the Bingham mining district, which will be published as a professional paper. The economic geology for this report was prepared by Mr. Boutwell and the areal geology by Mr. Arthur Keith in conjunction with Mr. Boutwell.

Mr. Boutwell also wrote a chapter on the gypsum deposits in Utah, to be included in a bulletin on the gyp-

sum deposits of the United States; contributed two short papers to Bulletin No. 213, one entitled "Progress Report on Park City Mining District, Utah," and the other "Ore Deposits of Bingham, Utah," and collaborated with Mr. Lindgren in the preparation of a report by the latter on the Clifton-Morenci mining district of Arizona, for which Mr. Boutwell prepared a special geologic map of the Morenci district.

Branner party.—The work done last year under the direction of Prof. J. C. Branner was confined to the Santa Cruz (California) quadrangle. Professor Branner was assisted by Prof. J. F. Newsom, who meandered and worked out in detail a large number of sections across the most difficult and inaccessible portions of the Santa Cruz Range. The field work was completed, with the exception of paleontologic investigations to be made by Mr. Ralph Arnold in order to determine definitely the ages of certain formations, with regard to which there is some doubt. It is expected that the folio will be completed and submitted for publication in the near future.

Calhoun party.—Under the direction of Professor Chamberlin, Mr. Fred H. H. Calhoun continued field work on Pleistocene geology in Montana. In 1901 the moraine of the northeastern ice sheet, interpreted as belonging to the Wisconsin epoch, had been traced by Mr. Calhoun from the vicinity of Fort Benton to the point where it crosses the forty-ninth parallel, about longitude 112° 20′. The work for the season of 1902 consisted in tracing this moraine across the State in an easterly direction, and in a study of the correlated phenomena. The tract studied lies between meridians 106° and 111°. In addition to tracing the glacial formations, the changes in drainage resulting from their deposition were studied, the former course of the Missouri was mapped between Great Falls and the mouth of Judith River, and the pre-Glacial courses of its tributaries were traced wherever possible. The Highwood, Little Rocky, and Bearpaw mountains were examined for evidences of local glaciation, with negative results.

Campbell party.—Mr. M. R. Campbell had charge of several parties engaged in areal and economic work in Pennsylvania, under an arrangement of cooperation entered into between the Director of the United States Geological Survey and the geologic and topographic survey commission of Pennsylvania. Under his supervision the survey of five 15-minute quadrangles was undertaken, as follows: The Waynesburg quadrangle, in Greene County; the Beaver quadrangle, in Beaver County; the Rural Valley quadrangle, in Armstrong County; the Eldersridge quadrangle, in Armstrong and Indiana counties; and the Slatington quadrangle, in Lehigh County. Mr. T. Nelson Dale was assigned to the survey of the Slatington quadrangle, Mr. Charles Butts to the survey of the Rural Valley, Mr. Lester H. Woolsey to the survey of the Beaver, and Mr. Campbell, assisted by Mr. Ralph W. Stone and Mr. Marcus L. Goldman, undertook the survey of the Waynesburg and Eldersridge quadrangles. This work was begun on July 1, but owing to illness Mr. Campbell was obliged to leave the field July 8, and the survey of the Waynesburg quadrangle devolved entirely on Mr. Stone. Mr. Campbell was not able to return to the field until August 29, but during that time he exercised general supervision by correspondence with the various parties. From August 29 to September 30 he was engaged in visiting the several parties and in gathering additional data regarding the geology of the Kittanning and Latrobe quadrangles.

From September 30 to October 19 Mr. Campbell was occupied in a visit to Ohio to supplement the work of Mr. Griswold in the Cadiz quadrangle, after which he proceeded to Charleston, W. Va., where he was joined by Mr. Butts, who assisted in procuring additional geologic data on the Kanawha Falls quadrangle necessary for the completion of that folio. Owing to pressure of office work Mr. Campbell was obliged to return to Washington October 31, but Mr. Butts remained and completed the work in the Kanawha Falls quadrangle.

Mr. Campbell spent the remainder of the year in the office, except two brief periods, one of which (April 4 to 24) he spent in company with Mr. David White in a special study of the Pocono rocks of the Allegheny Valley, Pennsylvania, and of the Salamanca-Olean region of New York, and the other (May 15 to 25) in a study of the Meadow Branch coal field of West Virginia.

During the year Mr. Campbell completed the Brownsville-Connellsville and the Latrobe (Pennsylvania) geologic folios, and three or four brief papers on subjects connected with his regular work, which were published in scientific periodicals.

Clark party.—Prof. W. B. Clark continued in charge of the Coastal Plain work in Maryland and adjacent States. He was assisted by Messrs. G. B. Shattuck, A. Bibbins, B. L. Miller, and M. W. Twitchell. The investigations during the year were confined largely to the study of the Potomac group and the late Tertiary and Pleistocene formations. The St. Mary quadrangle and parts of the Dover and Patuxent quadrangles were mapped, and the report on the St. Mary quadrangle was completed and submitted for publication, all in cooperation with the State survey.

Field work was also completed for a special monographic study of the Miocene formations. Some progress was made on a proposed monograph on the Pleistocene formations, which will be continued during the coming fiscal year, and considerable advance was made in a special study of the Potomac group. With the assistance of Mr. E. B. Mathews investigations which will afford the basis for folios were made in the piedmont area of Maryland, and similar studies were carried on, with the aid of Mr. G. C. Martin, in the Paleozoic formations in the western section of the State.

Cross party.—Mr. Whitman Cross devoted the month of July, 1902, to office work. On August 1 he left Washington for Honolulu, for the purpose of comparing the recent volcanic masses of the Hawaiian Islands with those of the much older volcanic region of the San Juan

Mountains in Colorado, which for several years has been his field of special investigation. On the outward journey a stop of several days was made at Mount Hood, Oreg., for the purpose of studying that volcanic mountain. Mr. Cross reached Honolulu on August 20, and remained on the islands until December 2. During that period he made reconnaissances of the four largest islands—Oahu, Kauai, Maui, and Hawaii—and gathered considerable information which will be of assistance in the future work of the Survey, in studies of both geologic and petrographic phenomena. Mr. Cross was so fortunate as to find the volcano of Kilauea in a state of activity, although not on a large scale compared with some former eruptions. Aside from the observation of the eruptive processes at Kilauea, the most important result of Mr. Cross's examination was the discovery of trachytic lavas on the island of Hawaii. Hitherto basalt was the only rock known from this group of islands, but Mr. Cross found an ancient topography of trachytic rocks almost entirely covered by the more recent basaltic lavas from Mauna Loa and Mount Hualalai.

Mr. Cross reached Washington December 21, after stopping a few days at the Grand Canyon of the Colorado, for the purpose of comparing the sedimentary section there with that of southwestern Colorado. After his return to the office he was engaged in the examination of referred manuscripts and in the preparation of the Silverton (Colorado) folio, which was completed and submitted for publication.

On January 8 Mr. Cross was designated geologist in charge of the section of petrology, and after that time devoted a large share of his time to administrative duties in connection with that section.

Dale party.—Mr. T. Nelson Dale was engaged from July 4 until September 18 in field work in the Slatington (Pennsylvania) quadrangle. From July 10 until August 31 he was assisted by Prof. Frederick B. Peck, and from September 2 until September 17 by Mr. Fred H. Moffit. In addition to the maps of the areal geology and the economic geology of that quadrangle, a large-scale map

was prepared, showing the size and location of the slate quarries around Slatington.

Mr. Moffit was engaged through July and August in completing the economic geology sheet of the Mettawee (Vermont-New York) folio, showing the marble belt of the Equinox and Pawlet quadrangles and the location of the working slate quarries in the Fort Ann, Pawlet, and Cambridge quadrangles. He also studied the Bald Mountain fault in the Schuylerville quadrangle in its relation to the areal geology of the Fort Ann and Cambridge quadrangles.

Mr. Dale spent several days in October in a visit to the newly prospected slate region of Martinsburg, W. Va. The remainder of the fiscal year to June 24 he devoted to the preparation of the texts of the Slatington and Mettawee folios, to writing a brief note on the slate industry at Slatington and Martinsburg (published in Bulletin No. 213), and to the completion of a professional paper entitled "Taconic Physiography." On June 25 he began field work in the Brandon (Vermont) quadrangle, assisted by Nelson C. Dale, field assistant.

Dall party.—Mr. W. H. Dall undertook no field work on account of the accumulation of office work, but in May, 1903, Mr. Frank Burns, his assistant, made a visit to the localities on the Rappahannock, in Middlesex County, Va., from which Conrad many years ago described some interesting Tertiary fossils, to obtain for the Survey as complete a series of the Miocene fossils of that region as possible, and at the request of Mr. Dall in May, 1903, Mr. T. Wayland Vaughan added to field work of his own the making of a reconnaissance of some shell-bearing marls reported at De Funiak Springs, Fla., with interesting results.

During the year a large number of fossils sent in by members of the Survey were studied and identified and reports on their age made to those interested. A detailed report, with illustrations, on the Pleistocene of Douglas Island, the Miocene of the Shumagins, and the newly discovered Eocene of Alaska, from data obtained during

the Harriman Expedition, was prepared and proof thereof read and corrected. This report will appear in one of the volumes of the Harriman Alaska series.

The manuscript for the report on Mr. Dall's studies of the Tertiary of Florida was also completed and is now in process of printing. This work includes a general revision of the post-Eocene Tertiary fauna, which has been practically untouched for half a century. A thorough revision of the classification, especially of the bivalves, has been obtained. Including Parts I–V, previously published, the work embraces about 1,500 quarto pages, with 60 plates, a geologic map, and other illustrations. During its preparation more than 8,300 species were compared or cited and 3,144 species were reviewed or described, 860 of which were new to science. All of these have been illustrated. The work concludes with a geologic summary, in which the various formations are defined and discussed and lists of their fossil fauna are given. The cost of illustration and publication of this work (which has been carried on since 1886 by the cooperation of the Survey with the Wagner Free Institute of Science, Philadelphia) has been borne by the Wagner Institute, and much of its success has been due to the active interest shown by the secretary of the institute, Mr. Joseph Willcox. The types of the species described are chiefly in the collection of the Survey, now forming part of the National Museum, and in that of the institute at Philadelphia. The work in its entirety forms the largest single contribution to the Tertiary invertebrate paleontology of the United States which has yet been made, and has an indirect bearing, through its reforms in classification, on all future work on American Tertiary fossils.

Darton party.—The work of Mr. N. H. Darton throughout the year was done chiefly in connection with the division of hydrography of the Survey, and was directed toward ascertaining the structure and stratigraphy of the central Great Plains region. Detailed mapping was continued in the adjoining mountain ranges on the west,

where the principal formations are upturned, especially in Wyoming and Colorado. Several months spent in the Bighorn Mountains, Wyoming, were devoted to completing the mapping of the Dayton and Fort McKinney quadrangles for folio publication. In this work Mr. Darton was assisted by Mr. C. A. Fisher, who gave special attention to the granite of the central area.

In continuing work in the Black Hills, the detailed mapping of the Sundance quadrangle was completed, and further studies were made of various questions of stratigraphy and structure. Later in the season this work was extended into the Aladdin quadrangle and the mapping of the geology was continued by Prof. C. C. O'Harra, who completed the survey of that quadrangle. Mr. Darton also finished the mapping of an area in the central portion of the Edgemont quadrangle which was not mapped by Mr. W. S. Tangier Smith the previous season.

During the office season Mr. Darton, jointly with Mr. Tangier Smith, prepared for publication the Edgemont (South Dakota) folio; progress was made in the preparation of the Aladdin, Fort McKinney, and Dayton (Wyoming) folios; and the Passaic (New Jersey) folio, which has been prepared jointly by Mr. Darton, Prof. J. E. Wolff, and State Geologist Kümmel is now nearly ready for transmittal. A report was also completed on the geology and water resources of the central Great Plains, on which Mr. Darton and his assistants have been working for several years. This report includes two maps of the region which embody all available data as to the geology and the prospects for underground water supplies. Much time was also devoted to the review of the Huron and De Smet (South Dakota) folios and of a report on the geology and water resources of a portion of the James River Valley in South Dakota, by Messrs. J. E. Todd and C. M. Hall. During the winter Professor Hall prepared maps and sections for the Casselton and Fargo (North Dakota) folios and for a report on a portion of the Red River Valley, but he died just as he was beginning work on the

texts. Arrangements have been made for the preparation of these by his former assistant and successor, Prof. D. E. Willard.

Diller party.—Mr. J. S. Diller spent the months of July, August, September, and the greater part of October in mapping the areal geology of the Redding (California) quadrangle. In this work, which was carried almost to completion, he was assisted by Mr. G. B. Richardson. The Redding quadrangle contains, besides many small gold mines, the two largest copper mines in California, and is of great economic importance. The geologic work was greatly facilitated by the cooperation of Mr. T. W. Stanton, who was with Mr. Diller's party from July 1 to August 15, devoting his whole time to collecting fossils, chiefly from the Jurassic and the Triassic, but also from the Carboniferous and the Devonian.

Between August 15 and September 15, accompanied by Mr. Stanton, Mr. Diller made a trip into the Klamath Mountains of Trinity County, Cal., for the purpose of obtaining, if possible, positive paleontologic evidence bearing on the structure of those mountains. Collections were made from two belts of limestone, one of which proves to be Devonian and the other Carboniferous, which contribute much to our knowledge of the general features of that region.

During the office season a brief report was prepared on the copper region of Shasta County, Cal., for publication in Bulletin No. 213; a paper on the Klamath Mountains was prepared and published in one of the scientific periodicals; several weeks were spent in revising the proof of the Port Orford folio and the text for a new edition of the Crater Lake special map, a demand for the latter having been created by the numerous excursions to that place and the action of Congress in making it a national park. Considerable progress was also made in the preparation of the Redding folio text.

During the month of June Mr. Diller completed the areal mapping of the eastern portion of the Redding quadrangle.

On June 1, 1903, Mr. Richardson was transferred to the division of hydrology, to assist Mr. Darton in hydrologic investigations in the Western States.

Eckel party.—In August, 1902, Mr. E. C. Eckel was assigned to work in the section of nonmetalliferous economic geology, under the immediate supervision of Mr. C. W. Hayes. Several weeks were spent in an examination of the salt and gypsum deposits of southwestern Virginia, after which an investigation was made of the gold deposits of the Dahlonega district, Georgia, which resulted in determinations of considerable practical value in regard to the structural relations and probable age of the deposits. Late in September Mr. Eckel made an examination of the slate, cement rock, and ocher deposits in the vicinity of Cartersville and Rockmart, Ga. The remainder of the field season, until November 9, was devoted to a revision of geologic boundaries in the Dalton (Georgia) and Fort Payne (Alabama) quadrangles. During the winter reports of the season's field work were prepared and published in Bulletin No. 213.

Field work was resumed on April 29, 1903, the object being the collection of data for a report on the Portland and natural cement industries of the United States. All producing areas will be visited and typical plants in each area will be examined. It is hoped to have the report ready for publication early in 1904.

Eldridge party.—Mr. George H. Eldridge spent the month of July in completing preliminary field studies in the petroleum districts of California, a brief report of which was prepared and published in Bulletin No. 213, while a detailed report is now in preparation. By this field work in California a distinct advance has been made toward the correlation of the formations of the Coast Range. Several weeks were also spent on a report relating to the phosphate fields of Florida, which will be completed during the next fiscal year. The remainder of the year was spent in the office in the preparation of the California oil report.

Emerson party.—Prof. B. K. Emerson continued, during the field season of 1902, his investigations of the intricate geology of the Becket and Tyringham quadrangles for the Housatonic folio, which will be completed within the next field season. In this work he was assisted by Mr. Joseph H. Perry, and part of the time was associated with Prof. W. H. Hobbs. The Becket gneiss, formerly assigned to the Cambrian, is found to be largely eruptive.

Professor Emerson was also occupied with the investigation of a very interesting and extensive development of a highly ferruginous and hydrous glass (palagonite) and of exceptional structures in the Triassic trap caused by the introduction of a calcareous mud into the interior of the thick sheet.

He also studied a remarkable area of early glacial topography on Mount Toby, consisting of small glacial corries and hanging valleys, and an extensive series of high, vertical rock terraces produced by the plucking action of the ice, all of which form a type of topography which may have been extensively developed during the oncoming of the ice and then destroyed by the continental sheet at its maximum. This unique area has been preserved in the lee of the great trap sheet forming Deerfield Mountain.

Work was also continued in the Ware quadrangle, chiefly in investigating the extensive basic differentiation borders of the great areas of Pelham and Monson gneiss, rocks which were formerly thought to be altered sediments, but which are now believed to be eruptive.

Fenneman party.—Prof. N. M. Fenneman, assisted by Mr. Chancey Juday, devoted the time available from his college duties to a study of the Boulder (Colorado) oil field. Mr. Juday collected data and samples from all wells in process of drilling. The results of the field work and study of the logs and samples were given in a preliminary report published in Bulletin No. 213. A detailed geologic map has been begun, embracing the oil field and portions of the adjacent foothills, and a full report on the area, including details of geology and all economic products, is in preparation.

Fuller party.—Under the direction of Mr. M. R. Campbell, from July 1 to September 10, Mr. Myron L. Fuller was engaged in the geologic survey of the Princeton and Haubstadt quadrangles in Indiana and the Mount Carmel and New Harmony quadrangles in Indiana and Illinois. In this work he was assisted by Mr. F. G. Clapp, who surveyed nearly the whole of the Haubstadt and New Harmony quadrangles. With Mr. Clapp's assistance the maps and text for reports on these four quadrangles were completed and submitted for publication as the Patoka folio.

During the year Mr. Fuller also prepared and submitted the Ditney (Indiana) folio, as well as brief reports on coal, oil, gas, and asphalt in southwestern Indiana, which were published in Bulletin No. 213, and an extended account of some of the Pleistocene features in the same region, which was published in the Bulletin of the Geological Society of America. The maps and text for the report on the Elmira (New York) quadrangle, which was surveyed prior to July 1, 1902, in cooperation with the State survey, were completed, except the paleontologic portions, which are awaiting the report of Mr. Clarke, State paleontologist.

On January 1, 1903, Mr. Fuller was transferred to the division of hydrology, hydrographic branch, and put in charge of hydrologic investigations in the Eastern States.

Gilbert party.—Mr. G. K. Gilbert spent the whole of the year in office work—during the summer months of 1902 at Ithaca, N. Y., and afterwards at Washington, D. C. Besides miscellaneous office work, including committee duty and the examination of manuscripts prepared for publication, he was occupied with the geologic reports of the Harriman Alaska Expedition and with studies of the structure of mountain ranges of western Utah.

In 1899 Mr. E. H. Harriman, of New York, took a party of scientists to Alaska as his guests, giving them facilities for investigation at various points on the coast. The party included four members of the Geological Survey—Messrs. W. H. Dall, B. K. Emerson, Henry Gan-

nett, and G. K. Gilbert—as well as several other officers of scientific bureaus of the Government. The cooperation thus begun by field work under joint auspices has been continued in the preparation and publication of reports. Mr. Harriman has incurred the principal expense of publication, thus contributing a large sum to the promotion of research, and various Government bureaus have given the services of expert scientific assistants. During the year Mr. Gilbert completed the preparation of a report on glaciers and glaciation, to constitute Volume III of the Harriman series, read proof of the same, and assisted in editing Volume IV, on geology and paleontology.

Volume III contains descriptions of the lower parts of glaciers approaching or reaching the sea, comparing their existing condition and magnitude with previous records, recording present condition as a basis for future comparisons, and incidentally discussing the subject of variation of glaciers. It describes the Pleistocene glaciation of the region visited, discusses the extent and history of Pleistocene glaciers and ice sheets and the magnitude of their erosive work, and treats of pre-Glacial topography. In this connection it describes two ancient peneplains, and indicates as probable a comparatively low pre-Glacial and early Glacial base-level. It describes pitted plains and kettle holes in process of formation; gives an example of littoral sculpture by means of the waves generated by the breaking away of icebergs; describes a topographic cycle on the backs of glaciers; discusses the importance of plucking as a method of glacier erosion coordinate with abrasion; notes a fallacy with regard to the pressure of tide-water glaciers on their beds, and analyzes the parallelism in the physical histories of glaciers and rivers.

Volume IV comprises an account of the general geology of the regions visited, by B. K. Emerson; papers on local geology and on minerals, by Charles Palache; descriptions of three local fossil faunas—Eocene, Miocene, and Pleistocene—by W. H. Dall; the description of a Jurassic biota, by E. O. Ulrich; and the description of a local Eocene flora, by F. H. Knowlton.

Mr. Gilbert also continued the study of notes and other materials, acquired in 1901, bearing on the structure of mountains of western Utah, and made some progress on the report. During the last week of June he began field work in the southern part of the Sierra Nevada—a study of the morphology of the range.

Girty party.—Mr. George H. Girty spent the time from August 19 to October 27 in the field, more or less closely associated with Mr. George I. Adams in Arkansas and Kansas, with Mr. R. T. Hill in New Mexico and Arizona, and with Mr. F. L. Ransome at Bisbee, Ariz., in studying the Carboniferous formations of the areas visited and in making collections of fossils and aiding wherever possible in the solution of stratigraphic problems.

In the office he completed the manuscript and read the proof for a report on the Carboniferous formations and faunas of Colorado, and made considerable progress on a report on the Permian fauna of the Guadalupe Mountains. Much time was also spent in the preparation of reports determining and correlating horizons in connection with the work of the stratigraphers.

Under Mr. Girty's direction, Messrs. Thomas Piwonka, Rector D. Mesler, and James Storrs were engaged for brief periods in collecting Carboniferous fossils from northern Ohio, northwestern Arkansas, and northern California, respectively.

Glenn party.—Under the supervision of Mr. M. R. Campbell, and in cooperation with the State of Kentucky, Mr. L. C. Glenn spent the field season between July 1 and September 16 in surveys of the Middlesboro, Ky., coal field, particularly in the Cumberland Gap and Jonesville quadrangles, giving special attention to the stratigraphy and structure of the area. In this work Mr. Glenn was associated with Mr. George H. Ashley.

During the office season Mr. Glenn completed and submitted for publication the maps and report on the Olean and Salamanca quadrangles, in New York, work which had been done in cooperation with the State survey.

Gregory party.—Prof. Herbert E. Gregory continued the laboratory study of the Connecticut crystalline rocks, and under the supervision of Professor Van Hise spent a small amount of time in field work in the Granby and Meriden 15-minute quadrangles. The summer of 1902 was spent in Europe—on leave—in a study of glaciation.

Griswold party.—Under the supervision of Mr. M. R. Campbell, Mr. W. T. Griswold, who was detailed from the topographic branch, spent the last two months of the field season of 1902 in the careful plotting of the geologic structure of a portion of eastern Ohio with a view to the study of the effect of the folding of the formations upon the accumulation of petroleum. The area studied was the southern half of the Scio quadrangle and the northwest quarter of the St. Clairsville quadrangle. During the months of April, May, and June similar work was continued by Mr. Griswold—who was again detailed from the topographic branch—in portions of the Wellsville and Steubenville quadrangles in Ohio and West Virginia, with the special object of obtaining data for building a model to illustrate the underground structure as plotted from the surface geology.

Hague party.—Mr. Arnold Hague was engaged in the work of the Survey about three-fourths of the time during the last year. He spent five weeks in field work, including all of August, in the Yellowstone Park, reviewing portions of the plateau and visiting certain points which he had not previously studied. This work related to problems connected with the great rhyolite flows which make up the broad central mass of the park. A portion of the time was devoted to a study of the geologic history of the Grand Canyon of the Yellowstone, and another portion to the investigation of the crystalline masses penetrating the Miocene breccias in the neighborhood of Sylvan Pass, on the border line between the park and the Yellowstone Park Forest Reserve. A large share of the time was devoted to the consideration of the question whether there has been any perceptible diminution in the intensity of thermal action in the geysers and hot

springs within recent years, or since they have been the subject of careful investigation. It has been stated from time to time that the discharge of these hot waters is rapidly falling off, and the statement has crept into scientific literature. A reexamination after an absence of five years convinced Mr. Hague that no such diminution in volume had occurred, although changes in points of discharge had undoubtedly taken place.

During the office season the large collections illustrating the siliceous sinters and sediments from the geysers and hot springs on the plateau and the travertine at Mammoth Hot Springs were arranged and labeled for deposition in the National Museum. This completes the work upon the collections, all other specimens having previously been arranged.

The greater part of the time Mr. Hague was engaged upon the completion of the first part of the monograph on the Yellowstone National Park, and much progress was made in the preparation of the final chapters.

Throughout the year Mr. Hague served as chairman of the library committee, and gave a portion of his time to the needs of the Survey library, in an endeavor to bring up the different sections to the requirements of the geologists and special investigators.

Hill party.—Mr. Robert T. Hill continued the study of the origin, occurrence, arrangement, and relations of the mountains west of that portion of the Cordilleran region lying west of the Pecos in Texas, New Mexico, and Arizona, which represents the northern continuation and end of the great North American regional feature known as the Mexican Plateau. In September, in company with Mr. George H. Girty, paleontologist, and Mr. T. L. Carothers, field assistant, he made a brief reconnaissance for the purpose of comparing the widely separated sections of Carboniferous rocks which play so important a part in the mountain structure of this region. This reconnaissance included an examination of the geologic sections at Las Vegas and Albuquerque, N. Mex., and the Grand Canyon in Arizona, and a study of the western

and southern edges of the Colorado Plateau and of the Sacramento Mountain section in New Mexico. In April, 1903, Mr. Hill, in order to procure additional data, made a short reconnaissance at his own expense into the Big Bend country of the Rio Grande. Inasmuch as the phenomena under observation all extend into Mexico, Mr. Hill improved every opportunity to study the geology of the plateau in that country, examination being made of the continuation of the Texas ranges into Chihuahua and other northern States of Mexico; also of the sections of the western Sierra Madre in Michoacan and across the Sierra Madre del Sur, all of which, it is hoped, will ultimately throw light upon the continental history. A visit was also made, at private expense, to the volcano of Colima.

In addition, Mr. Hill devoted much time to a continuation of the study of problems bearing upon the origin of the West Indies and their relations to continental evolution.

Hobbs party.—Prof. William H. Hobbs devoted about six weeks of the field season of 1902 to supplemental work in the Housatonic quadrangle of Massachusetts, under the supervision of Professor Van Hise, special attention being given to evidences of block faulting. The observations appear to show that faulting of the block type has profoundly affected the entire province of southwestern New England—to such an extent, in fact, that the present position of rock masses has been determined much more largely by this process than by the process of mountain folding, the evidences of which are everywhere present and, in contrast with the fault structures, easily detected.

During the office season Professor Hobbs's time was devoted chiefly to the preparation of a paper upon block faulting in southwestern New England and southeastern New York. This paper includes the results of studies extending over a period of several years.

Jaggar party.—Mr. T. A. Jaggar continued work on the Sturgis-Spearfish (South Dakota) folio, and prepared

a chapter on the general geology of that district for publication in the forthcoming bulletin on the mineral resources of the northern Black Hills, by Mr. J. D. Irving. He also continued work on the geologic map of the Bradshaw Mountains, Arizona.

The study of the petrography of the Bradshaw Mountains quadrangle and a manuscript on its mineral resources were completed by Mr. Charles Palache, who assisted Mr. Jaggar in the survey of that area, and they will be incorporated in the folio describing the quadrangle.

During the winter it was arranged that Prof. W. O. Crosby should collaborate with Mr. Jaggar in the preparation of the Boston folio, Professor Crosby treating the southern half and Mr. Jaggar the northern half. Mr. Laurence La Forge, assistant geologist, worked throughout the year on the Boston area, obtaining much valuable new material from the northern highlands. He also finished a bulletin on the geology of Somerville, Mass., which treats of many of the most essential and difficult problems of the geology of the Boston Basin.

During the year Mr. R. A. Daly, of the geological survey of Canada, completed a bulletin on the geology of Ascutney Mountain, Vermont. This work was begun in 1893, in collaboration with Mr. Jaggar, and represents an exhaustive study of the relations of plutonic rocks to metamorphic sediments.

Keith party.—Mr. Arthur Keith, assisted by Mr. Hoyt S. Gale, was engaged during most of the year on work in the mountain district of North Carolina, South Carolina, Tennessee, and Georgia. Field work extended from July 1 to November 21. Special investigations were made of the Archean rocks of the Asheville quadrangle and of the Cambrian strata of the Greeneville, Mount Guyot, Nantahala, Murphy, and Knoxville quadrangles, in order to clear up doubtful points before folio publication. Areal mapping was carried on in the Pisgah and Cowee quadrangles in North Carolina and South Carolina, the work on each being about half completed. Reconnaissance work was extended over adjoining areas in the Saluda

and Walhalla quadrangles, in North Carolina, South Carolina, and Georgia. This work pertained chiefly to the distribution of the Archean hornblende-gneisses, mica-gneisses, and granites, and the metamorphic schists and limestones of undetermined age.

During the winter the descriptive text of the report on the Bingham (Utah) mining district, which was prepared in conjunction with Mr. J. M. Boutwell, was completed and submitted for publication; special reports were prepared on the talc deposits of North Carolina and on the marbles of eastern Tennessee (published in Bulletin No. 213); also a résumé of the work done by the Federal Survey in North Carolina in cooperation with that State; the Greeneville, Asheville, and Nantahala (North Carolina-Tennessee) folios were completed and submitted for publication; the text for the Cranberry folio was reviewed and the proof was read, and considerable work was done on the Mount Mitchell, Roan Mountain, Walhalla, Pickens, Greeneville, and Saluda folios. In accordance with plans for cooperation with the Maryland State survey, Mr. Keith furnished that survey with descriptions and areal boundaries of the Archean formations in Prince George County, Md.

Kemp party.—Prof. J. F. Kemp spent the early part of the field season in investigating the local geology in and around the Rambler copper mine, southwest of Laramie, Wyo., a report on which was prepared during the winter and submitted in March. This copper-ore deposit is remarkable in that it also contains platinum and its related metals, and it exhibits peculiarities of structure and geologic relations, the excavations showing no vein formation, properly so called, but only secondary copper ores in decomposed country rock. The prevailing rocks of the region consist of gneisses and quartzites, with some intruded granite and gabbro. At the Rambler mine the gneisses are penetrated by a dike of quartz-diorite, in which the ore seems to occur. Peridotite is, however, exposed on a neighboring claim.

Considerable time was spent on the mapping of the Whitehall and Ticonderoga (New York-Vermont) quadrangles, in association with Mr. T. Nelson Dale. This region is a complex metamorphic one, and the topography is believed to be primarily the result of faulting.

Some time was also given to the preparation of a general review of the copper deposits of the United States.

Knight party.—Prof. Wilbur C. Knight continued his studies of the geology of the Laramie (Wyoming) quadrangle. A geologic section was extended across the Red Beds in the vicinity of Laramie and eastward to the Archean of the Laramie Mountains. The Red Beds rest upon a series of alternating limestones and sandstones, the fauna of which resembles to a marked degree that of the Permian rocks of Kansas. This series, which was found to be much thinner than previously reported, has at its base about 100 feet of coarse sandstones and grits, which rest upon the Archean and are the great water-bearing formation of the quadrangle.

Knowlton party.—Mr. F. H. Knowlton completed and submitted, on July 15, 1902, a manuscript and the illustrations for a paper on the fossil flora of the John Day Basin, Oregon, which was published as Bulletin No. 204. Since the completion of that work, he has been engaged in the study of the collections and the preparation of a manuscript on the flora of the Puget formation. Descriptions of about three hundred species have been prepared, and it is hoped that the work will be completed during the next year.

A considerable portion of Mr. Knowlton's time was consumed in examining and reporting upon fossil collections for various members of the Survey, notably on fossil plants from Alaska, for Messrs. A. H. Brooks, W. C. Mendenhall, and A. J. Collier; on fossil wood from South Dakota and on fossil plants from Wyoming and Colorado, for Mr. N. H. Darton; on plants from California and Oregon, for Mr. J. S. Diller; on plants from New Mexico, for Mr. D. W. Johnson; on a large collection

from eastern Oregon, for Prof. I. C. Russell; and on a collection from the Snoqualmie (Washington) quadrangle, for Mr. George Otis Smith.

In May, 1903, Mr. Knowlton spent a week examining a deposit of coal and lignite at the base of the Green Mountains in western Vermont. This deposit, which is of late Tertiary age, occurs in the midst of Silurian rocks, and forms a curiously isolated patch only a few hundred yards in area. A small collection of the associated rocks, the lignite, and the included fruits and leaves was obtained, the study of which, it is hoped, will throw light on the age of the beds referred to.

Lawson party.—Prof. A. C. Lawson continued, in office, work on the San Francisco Bay special folio, devoting to this work such time as was available from university duties. Under his direction Mr. E. D. Louderback completed the field work in the Mount Diablo quadrangle.

Leith party.—Under the supervision of Professor Van Hise, Mr. C. K. Leith spent the field season in general revisionary work in the various districts of the Lake Superior region for the final monograph on that district. In consequence of the economic development of recent years in the iron-bearing areas, it has become possible to more accurately delimit the formations than has been done in previous reports. This revision was well advanced at the close of the season, but to complete it will require much additional work.

In the office a large portion of Mr. Leith's time was devoted to the proof of the monograph on the Mesabi iron-bearing district. He also completed a report on rock cleavage for publication as a bulletin, and gave considerable time to the preparation of a base map to accompany the final monograph on the geology of the Lake Superior region.

Leverett party.—Under the direction of Professor Chamberlin, Mr. Frank Leverett spent the early part of July in a field conference with Mr. M. L. Fuller regarding Pleistocene problems in southwestern Indiana. He then proceeded to Michigan and took up field work in Manistee

County. This work embraced the mapping of the glacial deposits, the study of their structure, topography, and relation to water supplies, and the mapping of the several classes of soils. The work in northern and western Michigan was continued until November 7, after which it was extended into northwestern Indiana until November 26. It is estimated that a few weeks more of field work in Michigan and Indiana will be necessary to complete the data for the monograph on the Pleistocene features of those States, and it is planned to do this work early in the next fiscal year. In the northern counties of the southern peninsula of Michigan Mr. Leverett gave chief attention to the glacial features, and Mr. F. B. Taylor, who is collaborating with Mr. Leverett in the preparation of the monograph, to the features of lakes Algonquin and Nipissing, the predecessors of the upper Great Lakes. The glacial features of several islands which rose above the level of glacial Lake Algonquin, and also the features of the Beaver Islands in Lake Michigan, were studied and mapped by Mr. Taylor. The winter and spring months were devoted to the preparation of the manuscript for this monograph, which it is expected will be completed early in the coming year.

Lindgren party.—Mr. Waldemar Lindgren devoted nearly the entire year to office work, the only field work undertaken being a stay of three weeks in Placer County, Cal., for the completion of an investigation of the auriferous gravels of that region.

During the year Mr. Lindgren completed and submitted the maps and text for the Nampa (Idaho) folio, in conjunction with Mr. N. F. Drake, and for the Silver City (Idaho) folio, in conjunction with Messrs. Drake and F. C. Schrader; a reconnaissance report on the Bitterroot Range and the Clearwater Mountains in Montana and Idaho, for publication as a professional paper; a paper entitled "Test for Gold and Silver in Shales of Western Kansas," published as Bulletin No. 202; a paper entitled "The Water Resources of Molokai, Hawaiian Islands," published as Water-Supply and Irrigation Paper No. 77;

and a paper on the geologic features of the gold production of North America, published in the Transactions of the American Institute of Mining Engineers. Mr. Lindgren has also in preparation, nearly completed, a report on the copper districts of Clifton, Ariz.

Osborn party.—Prof. Henry Fairfield Osborn continued throughout the year in charge of vertebrate paleontology. His work was carried on in two lines, (1) the preparation and supervision of three paleontologic monographs, and (2) the planning of geologic field work connected therewith.

Professor Osborn, with the assistance of Messrs. W. K. Gregory and A. E. Anderson, continued work on the titanothere monograph, which was begun in January, 1901. This monograph has required more time than was anticipated, owing partly to the author's interruption by other duties and partly to the unexpected expansion of the subject by the discovery, in both the Oligocene and the Eocene, that the titanotheres embraced at least four entirely distinct and independent phyla. To learn the origin, history, succession, and extinction of these animals it has become necessary to trace the materials scattered through many museums, at home and abroad. Yale, Princeton, Harvard, Ottawa, Washington, and Pittsburg museums have been revisited; Mr. W. K. Gregory was sent to the British Museum of Natural History, London, for a special study of the titanothere material there; and work has also been done, with the aid of Dr. Max Schlosser, in Munich.

A special geologic expedition to the Fort Bridger beds, under the direction of Mr. W. D. Matthew, assisted by Mr. Walter Granger, which was made during the summer of 1902, laid the foundation for more exact stratigraphic data concerning the distribution of species, both of the titanotheres and of other mammals. A party from the American Museum, under the direction of Mr. Walter Granger, is now continuing the observations begun last season on the Bridger stratigraphy, and when these

results are ready Mr. Matthew will be able to present his report.

Mr. J. B. Hatcher, now of the Carnegie Museum, has been intrusted with the preparation of the monograph on the Ceratopsia, and in connection therewith has made, with Mr. T. W. Stanton, a special geologic reconnaissance in the Judith River region, Montana. Mr. Hatcher has completed the bibliographic and reference section, as well as the preliminary revision of the principal forms of the Ceratopsia, with very interesting results. Materials in the Yale University Museum have been further prepared for description through the cooperation of Prof. C. E. Beecher.

Mr. F. W. Lucas, of the United States National Museum, to whom has been intrusted the preparation of the monograph on the Stegosauria, has completed the preliminary outline, covering principally the materials preserved in the National Museum. He has succeeded in bringing together materials for a corrected restoration of the *Stegosaurus*, which differs in important particulars from the restoration by the late Professor Marsh.

The first steps in the preparation of a monograph on the Sauropoda, by Professor Osborn, have been taken in the collection of additional material, especially in the Como region of Wyoming, where a deposit, unexampled for richness, has during the last five years been surveyed under his direction.

Peterson party.—Under the direction of Professor Salisbury, Mr. William Peterson spent a portion of August and September in studying the former glaciation of the Bear River Range of Utah. On the east side of the range he traced glaciation for about 30 miles, locating a considerable number of large extinct glaciers, and establishing the fact of two widely separated glacial occupations of the region.

Prosser party.—During the year Prof. Charles S. Prosser devoted some time to a study of the East Columbus and West Columbus (Ohio) quadrangles, and under his

direction their mapping by Mr. Edgar R. Cumings is well advanced. The greater portion of Professor Prosser's time, however, was devoted to a study of the stratigraphy and areal extent of certain formations in Ohio, under the auspices of the Ohio State survey, the results being embodied in a preliminary report entitled "The Nomenclature of the Ohio Geological Formations," which appeared in the Journal of Geology.

Ransome party.—During the months of July and August, 1902, Mr. F. L. Ransome remained in Washington, engaged in the preparation of a report and a folio descriptive of the Globe (Arizona) quadrangle. These were completed and transmitted for publication on September 1. The report on the Globe copper district is now in press and will appear as Professional Paper No. 12.

After the completion of these reports Mr. Ransome proceeded to Bisbee, Ariz., and with the assistance of Messrs. J. Morgan Clements and Alfred M. Rock mapped geologically the Bisbee quadrangle, lying just north of the Mexican boundary. A detailed geologic map, on a scale of 1,000 feet to the inch, was made of that part of the quadrangle adjacent to Bisbee in which are the more important mines. The large and extensively worked bodies of copper ore occurring near Bisbee were thoroughly investigated with reference to their geologic relationships, origin, and probable future.

The survey of the Bisbee district was completed late in December, and a brief reconnaissance examination was made of the Commonwealth mine at Pearce, Ariz.

Mr. Ransome returned to Washington early in January, and wrote a brief account of the Bisbee copper deposits, which was published in Bulletin No. 213. Thereafter he was engaged in the preparation of the Bisbee folio and of a more comprehensive report on the same district for publication as a professional paper. Both of these manuscripts, with their accompanying maps and illustrations, are now ready for publication. During the year Mr. Ransome also served as a member of the committee on geologic names.

Reid party.—Prof. Harry Fielding Reid continued his work as special expert in charge of earthquake data. A careful record has been kept of all earthquakes occurring in the United States and its dependencies, about which any information could be obtained from newspapers or periodicals, from reports of the Weather Bureau or the Light-House Board, or by special correspondence. These records are preserved in permanent form in a card catalogue arranged chronologically, and are readily accessible. Special information was collected regarding the earthquake of February 8, whose center was in southern Illinois; also the earthquake of April 24, which occurred in northeastern Massachusetts and southeastern New Hampshire.

Russell party.—In July Prof. I. C. Russell resumed the study of the general geology and artesian conditions of southern Idaho, which was begun in 1901. Starting from Boise, with Messrs. Scott Turner and R. H. Dawson as field assistants, he made a reconnaissance of portions of Canyon and Owyhee counties, Idaho, and of Malheur and Harney counties, Oreg. Proceeding westward, the party extended the reconnaissance to Harney and Burns, Oreg.; thence southeastward to Stein Mountain and Alvord and Whitehorse valleys, and thence northward to Boise, where the party was disbanded in September.

In addition to the search for artesian basins, as much attention as the rapidity of the journey would permit was given to the study of the general geology, the development of topographic forms, and especially the nature of several groups of recent volcanoes. Visits were made to three centers of volcanic activity in Oregon, which furnished a large amount of instructive data concerning the nature of cinder and lava cones and the extensive lava flows discharged by them. At the close of the field season a visit was made to the Cinder Buttes in Blaine County, Idaho, for the purpose of revising and extending the studies of volcanic phenomena begun at that locality the year previous.

During the office season Professor Russell prepared a preliminary report on artesian basins in southwestern Idaho and southeastern Oregon, which has been published as Water-Supply and Irrigation Paper No. 78; also a report on the general geology, including a description of several recent volcanoes, for publication as a bulletin. These two reports are a continuation of the studies published in Bulletin No. 199.

Salisbury party.—Prof. R. D. Salisbury did little field work during the last year. A few days were spent in the Bighorn Mountains of Wyoming in initiating a study of the former glaciation of those mountains, the party being left under the immediate supervision of Mr. Eliot Blackwelder. Professor Salisbury remained in the mountains long enough to prove that there were two widely separated periods of glaciation, and gathered some evidence indicating a third glacial occupation. During May and June he spent some time in preparing the text of the Pleistocene geology for the Franklin Furnace and Passaic (New Jersey) folios.

Otis Smith party.—Mr. George Otis Smith was engaged in field work in the State of Washington between July 7 and October 3, during which period the geologic mapping of the Snoqualmie quadrangle was completed. He was assisted by Mr. Frank C. Calkins, assistant geologist, and by Mr. E. P. Carey, field assistant. During the latter half of November and the first week of December a preliminary field examination was made of the Bluehill (Maine) quadrangle, and for portions of the area the geologic mapping was completed.

During the office season the Mount Stuart (Washington) folio was completed and transmitted for publication, and the preparation of the Snoqualmie folio was begun. A report entitled "A Geologic Reconnaissance across the Cascade Range near the Forty-Ninth Parallel" was prepared, with Mr. Calkins as joint author, and transmitted for publication as a bulletin. A short paper on "Gold Mining in Central Washington" was prepared and published in Bulletin No. 213, and a paper entitled "Anti-

clinal Mountain Ridges in Central Washington" was published in the Journal of Geology. Some time was also spent in the review of referred manuscripts and in proof reading. From October 5 to February 15 Mr. Calkins was engaged in work for the division of hydrography.

Early in June field work was commenced on the coast of Maine, in the Bluehill and adjoining quadrangles.

Tangier Smith party.—Mr. W. S. Tangier Smith spent the first part of the field season in an investigation of the lead, zinc, and fluorite deposits of western Kentucky, in cooperation with Mr. E. O. Ulrich. In this work they were assisted by Mr. F. J. Fohs and Mr. A. F. Crider.

Some of the principal mines of the southeastern Missouri lead district were next briefly visited by Mr. Smith, and after that the remainder of the field season, until the middle of January, 1903, was spent in completing the investigation of the lead and zinc deposits of the Joplin district, Missouri-Kansas, which was begun in 1901. A geologic folio and a special report of this work will be prepared during the coming year.

In the Joplin district Mr. Smith was assisted by Mr. C. E. Siebenthal, who was engaged on the areal survey from July, 1902, until the middle of May, 1903, and who afterwards spent the greater part of a month in Washington in office work on the material gathered while in the field. For about two months of the field season Mr. Smith was also assisted by Mr. E. T. Hancock.

In the office about six weeks were spent in preparing material for the Edgemont (South Dakota) folio, and some time was also given to a study of petrographic collections from the Sundance (Wyoming-South Dakota) quadrangle. Preliminary reports of the work in western Kentucky and in the Joplin district were prepared and published in Bulletin No. 213. The remainder of Mr. Smith's time was spent in the preparation of the final report of his investigations in western Kentucky.

Spencer party.—A party in charge of Mr. Arthur C. Spencer was organized at Fort Steele, Wyo., on July 8, 1902, and proceeded at once to Encampment, Wyo., where

Mr. Spencer, with Prof. J. Volney Lewis as field assistant, was engaged in areal mapping and in the study of the mines and prospects of the Encampment special district until September 30, when Professor Lewis returned to his duties at Clemson College, S. C.

In September Mr. J. E. Spurr was assigned to cooperate with Mr. Spencer in an examination of the more important mines and prospects. Mr. Spurr spent two weeks alone in the field, and was then joined by Mr. Spencer, and a week was spent in joint study for the purpose of correlating the results of their observations. Afterwards Mr. Spencer made a short reconnaissance of the recently discovered copper prospects in the vicinity of Pearl, Colo. Messrs. Spencer and Spurr left Encampment on October 17, the former returning to Washington, and the latter going to Tonopah, Nev., to take up the study of that district.

A brief report on the Encampment work and an account of the reconnaissance at Pearl were published in Bulletin No. 213. Mr. Spencer's report on the copper deposits of the Encampment special district is now completed and will be published as a professional paper. The continuance of work in this region is contemplated during another field season, and eventually a complete description of the Encampment district will be published as a folio.

Spurr party.—Mr. J. E. Spurr, who had been absent from America since the spring of 1901 as consulting mining engineer to the Sultan of Turkey, resumed his duties with the survey in the spring of 1902. Illness, however, contracted soon after his arrival in Washington, prevented him from taking up active work until the latter part of August, when he was sent to Butte, Mont., as a delegate to the International Mining Congress which was being held in that city. From Butte he went to Encampment, Wyo., and spent a month in assisting Mr. A. C. Spencer in the examination of the copper deposits of that district. On the completion of the work at Encampment he proceeded to Tonopah, Nev., a new mining camp of considerable prominence, where he remained until early

in December, making a study of the ore deposits underground and a general examination of the surface geology, as well as trips to neighboring mining regions. A detailed topographic map being found necessary, Mr. W. J. Peters of the topographic branch joined Mr. Spurr at Tonopah and a map covering the region in which most active develment was going on was made. Pending the completion of the map Mr. Spurr returned to Washington, where he undertook the microscopic and comparative study of the volcanic rocks and other materials collected in Tonopah, and spent considerable time in revising and enlarging his manuscript entitled "The Descriptive Geology of Nevada South of the Fortieth Parallel," which will be published as Bulletin No. 208 of the Survey.

During the winter Mr. Spurr published the following papers in scientific periodicals: "A Consideration of the Differentiation of Igneous Rocks with Relation to Ore Deposition," published in the Transactions of the American Institute of Mining Engineers; "The Determination of Feldspars in Thin Section," published in the American Geologist; "The Application of Geology to Mining," published in the Proceedings of the International Mining Congress held at Butte in 1902.

In the latter part of April, 1903, Mr. Spurr resumed field work in the Tonopah district. He completed the areal geology before the close of the fiscal year and made several short trips to outlying mining regions. During the first month of this field work he was assisted by Mr. George I. Adams, and throughout the field season by Mr. Leon Dominian.

Stose party.—Mr. George W. Stose was occupied throughout the year chiefly with the duties connected with the editing of geologic maps. The report of this work will be found on pages 242 to 246.

During the month of August Mr. Stose was engaged in field work in the Mercersburg (Pennsylvania) quadrangle. The field notes, maps, and specimens collected have been partially studied in the office, but the final mapping and

the preparation of the folio text were deferred until the field work could be completed.

Taff party.—At the beginning of the fiscal year Mr. Joseph A. Taff was engaged in the areal and economic survey of the Muscogee (Indian Territory) quadrangle. On July 19 he was detailed to locate the public reservation at Sulphur, Chickasaw Nation, Ind. T., in cooperation with Mr. Frank C. Churchill, special inspector of the Department of the Interior. This work was completed and a report was submitted to the Secretary of the Interior on August 11. On August 12 Mr. Taff resumed areal work, and on September 10 the survey of the whole of the Muscogee quadrangle and of the northern third of the Sansbois quadrangle was completed. In this work he was assisted by Mr. S. W. Beyer from July 1 until September 6, and by Mr. J. W. Beede during the entire time.

On completing the surveys of these quadrangles Mr. Taff began the study of special geologic problems pertaining to the Paleozoic rocks in the Llano district of central Texas, in association with Mr. E. O. Ulrich and Mr. Bailey Willis, assisted by Mr. J. W. Beede. On October 1 he returned to Indian Territory, and in company with Mr. Ulrich undertook a reconnaissance of the southern part of the Ouachita Mountains, in the Choctaw Nation. This reconnaissance was completed October 20, and Mr. Taff returned to Washington October 23, when he was immediately detailed to select the commercially valuable coal and asphalt lands in the Choctaw and Chickasaw nations, Indian Territory, to be segregated by the Secretary of the Interior from allotment to the Indians. The time between October 23 and November 27 was devoted to the collection of data and maps preparatory to these surveys. Messrs. M. K. Shaler, Carl D. Smith, and R. D. Mesler were selected as assistants, under the direction of the Commission to the Five Civilized Tribes. The field work began on December 1 and was completed on March 10. There were selected for segregation 444,974.12 acres of coal and asphalt lands. In the selection of the coal lands it was necessary to extend areal

geology surveys over two-thirds of the Sansbois quadrangle and over a small part of the Canadian quadrangle. Mr. Taff's report was completed and submitted on March 19, 1903, when he returned to Washington.

The remainder of the year was devoted to office work, including the revision and extension of the text for the Tishomingo (Indian Territory) folio, the review of a preliminary report on the geology of the Arbuckle and Wichita mountains, and the description and classification of the coal lands in the Choctaw and Chickasaw nations, preparatory to their sale. The latter work is still in progress.

Tarr party.—Prof. R. S. Tarr continued work on the Pleistocene geology of the Ithaca, Dryden, Moravia, and Genoa (New York) quadrangles. The publication of this work will be delayed by the transfer of the party to the Pleistocene work for the Ithaca folio. The Pleistocene geology in this hilly country is proving to be very complex, so that in many valleys it is necessary to traverse nearly every acre of ground. This complexity results from the fact that the moraine extending across these northward-sloping valleys has extended tongues into them, and at various places has built lobate moraines, which are often obscure. In connection with these positions of the ice front were marginal lakes of varying level. Assistance in this work has been rendered by Messrs. W. E. McCourt, H. A. Allen, and C. R. Crosby, who have collected well records and worked out certain details.

Taylor party.—Under the direction of Professor Chamberlin, Mr. F. B. Taylor continued field work from July 1 to 15 on the surficial geology of the area to be included in the Taconic folio, in Massachusetts, New York, and Vermont, chiefly in the Greylock and Bennington quadrangles. The Greylock and Bennington sheets are nearly completed.

From July 25 until August 11 Mr. Taylor was engaged in field work on the glacial lake beaches and associated river formations in southeastern Michigan, in connection with the preparation of a monograph in collaboration with

Mr. Frank Leverett. The investigations were chiefly in a strip bordering the Detroit and St. Clair rivers and Lake St. Clair. In connection with the first breaking of the St. Clair and Detroit rivers over the moraines which crossed their valleys near St. Clair, Detroit, and Trenton, a remarkable series of distributaries, or abandoned temporary channels, was found. Most of the beaches in this area are very faint.

From August 26 until November 20 Mr. Taylor was engaged in studying the abandoned shore lines in northern Michigan. A week was spent on the Beaver Island group, in Lake Michigan, in investigating the beaches and the glacial deposits.

Ulrich party.—Under a plan of cooperation between the Director of the Geological Survey and the curator of the geological department of Kentucky, an investigation of the areal and economic geology of the lead, zinc, and fluorite district of western Kentucky was undertaken by Messrs. E. O. Ulrich and W. S. Tangier Smith, assisted by Messrs. A. F. Crider and F. Julius Fohs. Mr. Ulrich and Mr. Smith spent nearly two months in this field, and after their departure to other districts the work was continued by Messrs. Crider and Fohs until September 4. Early in November Mr. Ulrich returned to the field, with Mr. R. S. Bassler, of the United States National Museum, and another month was spent in areal work and in collecting fossils. The field work extended over the counties of Livingston, Crittenden, and Caldwell, and over adjoining portions of Lyon and Christian counties, in Kentucky, and Pope and Hardin counties in Illinois. The preparation of maps and manuscripts for this report was begun in the office late in March, and proceeded, with interruptions, to the end of the fiscal year. The report embraces maps of the counties of Livingston, Crittenden, Caldwell, and Lyon, showing the distribution of geologic formations and the location of faults, veins, and mines; also a full description of the stratigraphic and economic geology of the region.

On August 24, Mr. Ulrich joined Mr. George I. Adams's party in northern Arkansas, for the purpose of investigating the faunal and stratigraphic relations of the Paleozoic rocks in the Yellville and Fayetteville quadrangles. Large collections of fossils and detailed sections of the formations were made, and in order that the correlations might be as exact as possible, the type localities of nearly all of the formations distinguished in northern Arkansas were visited and studied.

On September 10, Mr. Ulrich proceeded to central Texas, where until September 29 he was associated with Mr. Joseph A. Taff's party in a study of the faunal and stratigraphic problems presented by the Paleozoic rocks in Lampasas, San Saba, Llano, and Burnet counties. Similar studies in the Ouachita Mountains of Indian Territory engaged the same party from September 30 until October 20. The object of these investigations was to determine the stratigraphic relations of the geologic formations of these areas to those studied during the preceding season in the Arbuckle and Wichita mountains of Indian Territory and Oklahoma.

From the Ouachita Mountains Mr. Ulrich proceeded to southwestern Ohio and southeastern Indiana, to continue his investigations of the stratigraphic and structural problems connected with the Ordovician-Silurian boundary. Here he was joined by Mr. R. S. Bassler, and ten days were spent on work, the results of which will have an important bearing on the solution of several perplexing stratigraphic problems of the Ohio and Mississippi valleys.

In the office Mr. Ulrich was chiefly occupied in the preparation and study of the collections of fossils secured in northern Arkansas, southern Missouri, the Arbuckle Mountains of Indian Territory, and the Wichita Mountains of Oklahoma. Among the important results of these studies are (1) the revision, correlation, and final classification of the Paleozoic rocks beneath the Coal Measures in northern Arkansas, for use in mapping the

geologic formations in quadrangles on the southern side of the Ozark Plateau; and (2) the determination and correlation of pre-Carboniferous horizons in the Arbuckle Mountains, and a preliminary determination of their equivalents in northern Arkansas, in the Wichita Mountains of Oklahoma, and in central Texas. Considerable time was also devoted to a revision of the maps and manuscripts for the Columbia (Tennessee) folio, now published, and in reporting on numerous small collections of Ordovician and Silurian fossils sent in by geologists of the Survey and of State surveys having cooperative relations with the Federal Survey. Ten days were also spent in the completion of a report on Alaskan Liassic fossils which is now in course of publication as a part of Volume IV of the Harriman Alaska series.

Vaughan party.—Mr. T. Wayland Vaughan devoted the greater portion of the year to the preparation of a monograph on the later Tertiary corals of North America. One month was spent in visiting and studying type specimens of corals in the Museum of Comparative Zoology of Harvard University, the Boston Society of Natural History, the Peabody Museum of Yale University, the American Museum of Natural History of New York, and the Academy of Natural Sciences of Philadelphia. During the year about 75 genera and their species were studied more or less thoroughly, and considerable progress was made in the preparation of the manuscript.

The period from April 23 to May 29 was devoted to field work in the vicinity of Albany and Savannah, Ga., and at De Funiak Springs, Fla. The former places were visited for the purpose of investigating the probability of the occurrence of petroleum, and the journey to the latter place was made for the purpose of making collections of Tertiary fossils, with a view to determining the stratigraphic position of the horizons represented there.

Mr. Vaughan also prepared a short report on the fuller's earth deposits of Florida and Georgia for publication in Bulletin No. 213.

Ward party.—Mr. Lester F. Ward spent a large portion of the time during the last year in the completion of his second paper on the status of the Mesozoic floras of the United States. The first paper appeared in the Twentieth Annual Report, Part II. The final chapter—on the flora of the Older Potomac—proved the most extensive and difficult one, and required most of the time to the end of May. It contains a historical review and sections on the Maryland cycads (to which a report was contributed by Mr. Arthur Bibbins), and one on recent collections of fossil plants from the Older Potomac of Virginia and Maryland. The collections from Virginia, the District of Columbia, and Maryland were largely made by Mr. Ward, and represent many new localities. Mr. Bibbins has also obtained great quantities of valuable material from sources in Maryland not previously known to yield fossil plants. All the fossils were elaborated by Professor Fontaine. This report is now complete and has been submitted for publication.

Work was also continued on the "Compendium of Paleobotany," in connection with which a short trip was made to the libraries of New York, Boston, and Cambridge, and a few days were spent in Philadelphia in consultation with the leading diatomists of the country regarding the literature on fossil diatoms. During the year Miss Schmidt continued to gather material for this bibliography. Professor Ward sailed for Europe June 6, and spent the latter half of that month in consulting rare works in the libraries of Paris.

Weed party.—Mr. Walter H. Weed devoted a large part of the year to office duties, chiefly in the preparation of the Marysville (Montana) folio, the field work for which was completed the preceding year, and in the preparation of a report on the economic geology of the Butte mining district, Montana. A short field season in August and September was spent at Butte, chiefly in underground work on the mines. Brief visits were also made to various copper mines in New Jersey and North Carolina, to

obtain data for a report on the copper deposits of eastern United States.

Weeks party.—Mr. F. B. Weeks spent the month of July in completing the bibliography of North American geology and paleontology for the year 1901, after which, acting under instructions of the Director, he turned his attention to a study of the methods of library administration of the Library of Congress, of several of the large libraries of New York City, and of the library of Harvard University, for the purpose of determining the best methods to be adopted in the management of the Survey library. On December 15 Mr. Weeks was appointed librarian of the Survey, relinquishing the position of assistant geologist, which he had held for several years. Before his appointment to the position of librarian he completed about one-third of the bibliography of geology and paleontology for the year 1902.

White party.—Mr. David White, in connection with his work on the determination of the age and the classification of the Appalachian Coal Measures formations, has taken up the question of the age of the Dunkard formation, now being mapped in a number of the quadrangles in southwestern Pennsylvania and eastern Ohio. The preliminary study of the fossil plants obtained during a brief period of collecting confirms the earlier reference of the beds above the Washington coal to the Rothliegende, and establishes the presence of Permian beds in the Appalachian trough. Further paleontologic data being necessary for a satisfactory conclusion respecting the remainder of the Dunkard, the task of making additional collections with special reference to this point was committed to Mr. T. E. Williard, who spent the greater part of the month of June, 1903, in the field.

On account of the widespread interest in the anthracite basins of Morgan County, W. Va., which were thought by some geologists to be of Pottsville (Upper Carboniferous) age, a brief examination and paleobotanic study of the area was made by Mr. White early in December,

and he reports the coals to be Pocono, notwithstanding their local thickness and anthracitic character.

Additional special field paleobotanic studies were made in April to fix the Pennsylvanian-Mississippian boundary along the Allegheny River in the Kittanning and Rural Valley quadrangles, and to determine the age of the Olean conglomerate in the vicinity of Bradford, Pa.

During the remainder of the year Mr. White was chiefly occupied with the elaboration of the Pottsville floras, especially those of the Sharon and Mercer groups in Ohio and Pennsylvania. It being shown by these studies that a large part of the Kanawha formation in southern West Virginia is to be correlated with the Mercer group, a field investigation of the problem, with the object of determining the boundary between the rocks of Allegheny and Kanawha age in the central portion of the latter State, was carried on during the greater parts of May and June.

Williams party.—Prof. H. S. Williams, assisted by Mr. Edward M. Kindle, continued the correlation and classification of the Devonian formations of Maine, Pennsylvania, New York, and Arizona.

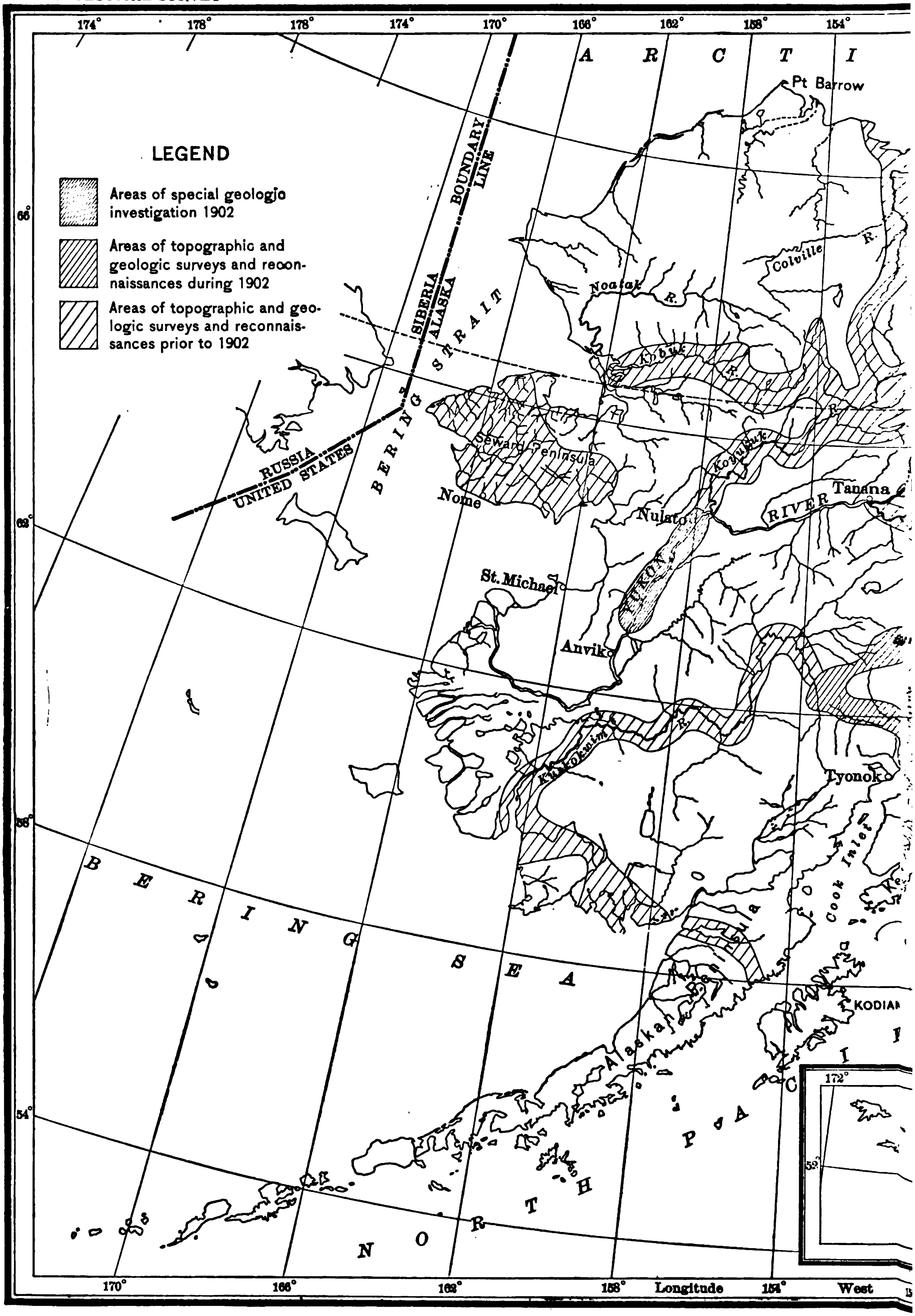
Field work was carried on during the months of August and September in McKean, Warren, Crawford, and Erie counties, Pa., for the purpose of determining the relationship existing between the stratigraphic range of the Upper Devonian and the Lower Carboniferous faunas. A review was also made of the faunal successions in the Waverly and Owego (New York) quadrangles. During the month of June Mr. Kindle accompanied Mr. M. L. Fuller over the Elmira (New York) quadrangle, for the purpose of collecting fossils to be used for the correlation of zones in that district. Nineteen more or less continuous sections were examined, and large collections of fossils were made. During July Mr. Kindle was on leave of absence from Survey duty, running a section across Indiana for the Indiana State survey, but incidentally he made large collections of the Niagara faunas.

During the year the Devonian faunas of the Globe and Bisbee (Arizona) quadrangles were examined and reported on, and a report on the Devonian faunas of Virginia, West Virginia, and Kentucky was completed, as was also a bulletin (No. 210) on the correlation of geologic faunas, in which the geographic relations of Devonian faunas and the principle of the shifting of faunas coordinate with the accumulation of sediments were discussed. Successive faunules in the several long local sections of the Devonian were identified, and faunal charts of these were prepared as standards for correlation. Progress was also made in the identification of the fossils of several shorter local sections in New York and Pennsylvania. Correlation problems of the Salamanca (New York) quadrangle were studied and report was made of the results for the classification of its formations. Progress was also made in the preparation of illustrations of the Chapman fauna of Maine.

Wolff party.—Prof. J. E. Wolff completed the survey of the northwest corner of the area covered by the Passaic (New Jersey) folio, comprising 75 square miles of pre-Cambrian rocks, and finished the maps and text for the same. In this work he was assisted by Messrs. Laurence La Forge and Charles W. Brown. Professor Wolff also completed the maps and text for the Franklin Furnace (New Jersey) folio, made a final study of certain doubtful geologic features on the summit and slope of Hoosac Mountain for the Taconic (Massachusetts-Vermont) folio, and made a brief reconnaissance of the Wilmington (Vermont) quadrangle.

Investigations in Alaska.

The Alaskan surveys and investigations were continued under a committee composed of R. U. Goode, geographer, and Alfred H. Brooks, geologist in charge of geologic work in Alaska, until Mr. Goode's death, which occurred June 9. These surveys have been carried on continuously since 1898, under an appropriation made for investigation of the mineral resources of Alaska. The



MAP OF ALASKA, SHOWING PROGRESS OF TO

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expansion and importance of this work, together with its peculiar features, led to a recommendation to the Secretary of the Interior that it be constituted a distinct division of the Survey, to be entitled the division of Alaskan mineral resources, and that Mr. Alfred H. Brooks be made its chief, with the designation geologist in charge.

Under authority of an act of Congress making appropriation of $60,000 for a continuation of the investigation of the mineral resources of Alaska, five parties were actively engaged in field work during the summer of 1902. Of these one carried on a reconnaissance survey and exploration from Cook Inlet to the Yukon through the Alaskan Mountains and along the northwestern base of Mount McKinley; two others were engaged in geologic and topographic mapping in the Copper River Basin; a fourth was instructed to make a reconnaissance of the coal deposits of the Yukon River; while a fifth made a detailed topographic survey of a part of the Juneau mining district, in southeastern Alaska. All of these parties were successful in carrying out their field instructions. (See Pl. I.) After their return to Washington the members of the Survey engaged in Alaskan work devoted their time to the preparation of the maps and reports.

COPPER RIVER BASIN.

The rapid exploitation of the gold placers in the Copper River Basin, and the sustained interest in its copper deposits, led to an urgent demand in 1902 for a continuation of the earlier work in this region, which had proved to be of much practical value to prospectors, engineers, and others. In 1898 Mr. F. C. Schrader, while attached to an Army expedition, mapped the lower Copper River and made a study of its geology, and Mr. W. C. Mendenhall traversed the western border of the basin. In the following year Messrs. Peters and Brooks made a reconnaissance survey of the upper waters of the Tanana and White rivers, which lie east and north of the upper Copper River, while Mr. Rohn made a reconnaissance of the

Chitina River and the Scolai Mountains. In 1900 Messrs. Schrader, Spencer, Gerdine, and Witherspoon extended geologic and topographic mapping to the Chitina Valley, which is tributary to the lower Copper River Valley.

For the season of 1902 it was planned that work of the same character as that begun in 1900 should be carried over the remaining portion of the Copper Valley and the upper parts of the Nabesna and Chisana valleys, and connected with the earlier more purely reconnaissance surveys. For the purpose of carrying out this plan the field was divided between two parties; one mapped the upper Copper River and adjacent parts of the Tanana Basin, and the other the Chistochina gold fields and the central portion of the Copper River Valley. Mr. F. C. Schrader, geologist, and Mr. D. C. Witherspoon, topographic assistant, were detailed to carry out the work in the northern area, and Mr. T.G. Gerdine, topographer, and Mr. W. C. Mendenhall, geologist, were assigned to the southern field.

Mr. Gerdine's party was to begin work at Copper Center, over 100 miles from the coast, and Mr. Schrader's party at Batzulnetas, about 100 miles farther inland. As the common route to the various fields of operations lay in part along the Government trail over the Chugach Mountains, which are deeply covered with snow until early summer, it was decided to send the season's supplies to the interior by horse sled in winter, a plan now generally followed by operators in the Copper River Valley, since the snow and the frozen condition of the streams then form smooth highways, over which heavy loads can be drawn. Mr. Schrader organized this work for the combined parties, and the task of carrying out the plans was assigned to Mr. Witherspoon, who landed at Valdes late in February with a party of 15 men and 20 horses, and before the disappearance of the snow and ice succeeded in transporting the supplies, amounting to about 20 tons, across the mountains to their destination in the interior. About one-half of these supplies were left at Copper Center, over a hundred miles inland, and the rest were

taken a hundred miles farther up the Copper River to the Indian village of Batzulnetas. Mr. Witherspoon deserves great credit for the successful execution of the plans, which, as they were carried out during winter weather, involved much exposure and discomfort and required very careful management.

NORTHERN PARTY.

Mr. Witherspoon began topographic work near Batzulnetas early in May by measuring a base line along the Copper River, from which the work was expanded and carried on by a system of plane-table triangulation and contour sketching. Elevations were determined by vertical angles, though aneroid records were also kept. Control and locations were obtained by intersections on the peaks of the Wrangell Mountains and by latitude observations. These locations were considered accurate enough for the character and scale of the mapping.

Mr. Schrader, who was detained in Washington by office work, reached Mr. Witherspoon's base camp at Batzulnetas, on the upper Copper, June 14. Here, on June 16, he was joined by Mr. Witherspoon on his return from the Mount Sanford and Copper Glacier district, 30 miles distant, to which point he had already extended his topographic work. Organization and plans for the season's field movements were at once formulated, in which act the knowledge of the country already gained by Mr. Witherspoon was of material aid, and subsequently tracings of his work, which preceded that of the geologist, were found to be very accurate and serviceable as a base map for the geologic work.

Previous experience with the atmospheric conditions of the Copper River country and the shortness of the season made it evident that the success of the work required that the topographer and the geologist, though working cooperatively, be equipped to move independently of each other. The party was accordingly divided into three sections—topographic, geologic, and pack train—and the

general plan followed was to carry the work southeastward in a broad belt on the north slope of the Wrangell and Scolai mountains, across the heads of the Copper, Nabesna, and Chisana rivers, connecting with the surveys made by Peters and Brooks and by Rohn in 1899, and reaching as far southward above snow line and the glaciers as conditions would permit; and then, returning westward, to carry it in a similar belt contiguous to the above on the north. It was also contemplated to make a hasty side trip from the Chisana to the copper deposits on the middle White River, about 50 miles eastward, if time would permit.

At first operations were hampered by the fact that the party was dependent for horse feed on grass, which did not make its appearance until late in June. After this date, however, sufficient grass was generally found for the sustenance of the pack animals until near the end of the season.

On June 19 Mr. Witherspoon, in charge of the topographic section, set out with two weeks' supplies from Batzulnetas northward and began carrying his work from the Slana River southeastward through the Mentasta Mountains by way of Suslota Pass and Buck and Platinum creeks to the Nabesna; and on June 22, as soon as grass began to appear, Mr. Schrader, with the geologic section, about two weeks' supplies, and a canvas boat, crossed the Copper at Batzulnetas and carried the geologic work southward up Drop Creek to snow line, several miles above the foot of Drop Glacier, on the north slope of Mount Sanford. From here it was extended eastward across the rugged, mountainous lava country of andesites and basalts at the head of the Copper River, and finally by way of Pass and Wait creeks to the Jacksina, where, 35 miles from Batzulnetas, the base of new supplies established by the pack-train section was reached July 3, and where the topographic section, which had not been heard from since June 19, arrived at about the same time, each section having been materially delayed in the progress of its work by bad weather. Though repeated trials were

made, the party was prevented by rain and fog, until July 8, from completing its work here from a commanding and important mountain rising nearly 5,000 feet above camp.

On July 9 the geologic sections, with several weeks' supplies, proceeded with the work up the Jacksina to Tumble Creek. Messrs. Witherspoon and Schrader had planned to make a joint exploration by back-packing from the foot of the Copper Glacier to the foot of the Nabesna Glacier; but Mr. Witherspoon injured one of his ankles by the rugged mountain climbing incident to the work, and it soon became greatly swollen, discolored, and very painful, so that it was apparent that he would require at least two weeks to recuperate, and the plan of making a joint glacier trip was dropped. Mr. Schrader accordingly, having completed the work in the Tumble Creek region, whose rocks are essentially an eastward extension of the Copper River lavas, carried the geologic work to the head of the Jacksina and then, by way of Monte Cristo Creek, 20 miles eastward, to the Nabesna.

At the head of the Nabesna the progress of the work was less rapid, by reason both of the occurrence of copper, gold, and iron, and of more complex geology, which required careful examination. The work was then carried down the Nabesna a distance of about 20 miles, to the north base of the Nutzotin Mountains, at the mouth of Jack Creek, where the pack-train section in the meantime had established a new base of supplies, which was reached August 6. At about the same time the topographic section, whose chief, with a disabled ankle, had been left with three other men at Tumble Creek on the upper Jacksina, arrived. As the topographic results which the proposed arduous glacier trip was expected to yield were obtained from a high snow peak, the glacier trip was abandoned and, replenishing his larder with fresh meat from the hundreds of mountain sheep that throng the snowy heights in this region, Mr. Witherspoon continued his topographic work eastward by way of the Jacksina and Monte Cristo Creek to the Nabesna, where, in the meantime, a small relay of supplies had been cached

for him at the foot of the glacier by the pack-train section. Having mapped the head of the valley, he descended it on the west to the Jack Creek supply base.

It was now too late to make the trip to the White River, so the horses that had become crippled or weakened were turned out to recuperate for fall use, and were replaced by good ones from the pack train. On August 7 and 8 the topographic and geologic sections, respectively, set out with renewed supplies and reduced outfits, and carried the work by way of Copper Creek, Cooper Pass, and Notch Creek southeastward to the Chisana River, the East Fork of the Tanana.

On the Chisana the south forks of Notch Creek and Cross Creek were examined and mapped to their glacial sources, and Euchre Mountain was ascended by both the topographer and the geologist. Mr. Witherspoon next extended the topographic work northeastward to the head of Chathenda Creek, where he hoped to cross the mountains to the north toward the White River, but finding no pass practicable for pack animals, was forced to return to the Chisana. Both sections then descended through the so-called canyon of the Nutzotin Mountains to the open Tanana Valley. From here the work was continued northwestward along the north base of the Nutzotin Mountains to the Nabesna, whence, after obtaining supplies and horses on August 29 from the Jack Creek base, Mr. Witherspoon continued northwestward by way of Tuck Creek and the Little Tokio into the Alaskan Mountains to the Tokio River, a distance of 50 or more miles. Meanwhile the geologic section proceeded northwestward through the heart of the Mentasta Mountains by way of Jack, Bear, and Buck creeks, Suslota Pass, Suslositna Creek, and the Slana River, to Mentasta Pass.

At the same time the pack-train section proceeded from the Nabesna to Batzulnetas, the original supply base, and procured provisions and needed survey material, which, according to arrangement, it delivered at Mentasta Pass September 9, almost simultaneously with the arrival there of the other two sections. Here, at the post-office and

signal station, the first news of the Gerdine-Mendenhall party and of the outside world since early in June was received. As the snow line was daily descending the mountain slopes and the horses were growing weak since the cold frosty nights had killed the grass, it was decided, before the sections again separated, to close the season's work and meet at Indian Creek about September 20. Accordingly the topographic work was next carried northwestward up the Slana and thence southward along the divide west of Ahtell Creek to near the Copper, while the geologic work was extended northeastward through Mentasta Pass to the Little Tokio. Later, from a point a few miles above the Government trail on the south side of the Slana River, it was carried by way of the trail and Slana Pass southwestward nearly to the Copper River. Here the topographic and geologic sections camped together on the night of September 18, and on the following day, near Indian Creek, overtook the pack-train section, which after leaving Mentasta Pass had returned to Batzulnetas and procured the rock and mineral collections and the supplies needed in making the journey to Valdes. As there was no grass or other horse feed at Indian Creek, the party continued its march, and late in the evening reached the cache left at Chistochina early in the spring. From here by rapid marches the party arrived at Valdes September 30, and the next day took passage on the steamer *Santa Ana* for Seattle, where it arrived on October 14 and was disbanded.

The region mapped by Mr. Witherspoon includes the north slopes of the Wrangell and Scolai mountains and the larger part of the Nutzotin and Mentasta mountains. It is drained by the upper courses of the Copper, Tanana, and White rivers and their tributaries, and includes a total area of about 4,800 square miles. On the east the work is connected with the surveys made by Peters and Brooks and by Rohn in 1899, and on the west with those of the Gerdine-Mendenhall party in 1902.

The results of Mr. Schrader's geologic studies may be briefly summarized as follows:

The rocks on the north slope of the Wrangell and Scolai mountains were found in general to be similar to those in the better known Chitina region on the south side. They consist principally of andesitic and basaltic lavas, a diabasic series, diorite, and limestone.

The upper Copper River portion of the above region is essentially a barren waste of recent and older andesitic effusives, with some basalt. These consist of many sheets or flows and beds of tuff, superimposed, which in general lie nearly horizontal or dip gently northward. They extend eastward nearly to the Nabesna and northward toward the Mentasta Mountains.

Toward the Nabesna the above lavas, especially the andesites, diminish in amount, and by faulting and erosion older rocks are exposed. The latter consist of several groups, of which the principal are the Monte Cristo diorite, Nabesna limestone, the diabasic series, and northward the Mesozoic series of the Nutzotin Mountains.

The Monte Cristo diorite is a dark-gray, coarse-grained rock, occurring principally on Monte Cristo Creek, where it is exposed in an area of a few square miles. It weathers to a reddish-brown or bright-orange color, due to iron oxide derived from its contained pyrite, which seems to be auriferous. It appears to be one of the oldest rocks in the region, is greatly crushed and altered, and is intruded by dark diabase.

The Nabesna limestone is a heavy-bedded, more or less crystalline, light-colored rock, occurring in the Wrangell and Scolai mountains on the upper Nabesna and Chisana rivers, where it is faulted and folded and is associated with diabasic intrusives. It is fossiliferous, but no determinative forms were found. It is regarded, however, as Permian, and may be identical with the Chitistone limestone, with which the copper deposits on the south are associated.

The diabasic series comprises a group of volcanic rocks whose lower members appear to be older than the Nabesna limestone, and some of whose younger members are intrusive in it. At some localities the rocks consist of

heavy sheets or flows, which future study may resolve into more than one series. The lower members somewhat resemble the Nicolai greenstone. The series occurs on both the Nabesna and the Chisana rivers and intermediately. It is of economic importance, since it seems to be the source of the copper and iron found in the northern field, and has locally metamorphosed the rocks into which its members are intruded.

The Mesozoic series, which is exposed in the Nutzotin Mountains, lying just northeast of the Scolai Mountains, consists mainly of slates, shales, thin-bedded dark limestones, graywacke, and conglomerates. Though these rocks are known to carry gold, it has not yet been found in workable amount. From paleontologic evidence the series is found to range in age from Triassic to Lower Cretaceous. On the Nabesna it seems to rest unconformably on the Nabesna limestone. To the west it is represented as far as Mentasta Pass, where it seems to rest on Carboniferous limestone and apparently a still older series of micaceous quartz-schists. Between the Chisana and the Slana it is occasionally intruded by greenish dioritic masses.

The rocks forming the mountains bounded by the big bend of the Slana on the east and north and by Indian Creek on the west seem to be essentially a series of dioritic masses, with some other greenstones. The same is true of the region just east of the Slana, especially south of Suslositna Creek.

The investigations of last season also threw additional light on the glaciology of the region, especially along the north slope of the Wrangell, Nutzotin, and Mentasta mountains.

In the prosecution of the geologic work special attention was paid to the occurrence of copper and gold. The copper deposits, as far as known, occur mainly on the north slope of the Wrangell and Scolai mountains and in much the same class of rocks as those of the southern belt, namely, in the supposed equivalent of the Nicolai greenstone and the associated limestone. None of the

occurrences thus far discovered promise to be of economic value. There is reason to hope, however, that better prospects may yet be discovered.

Although colors of fine gold are found in some of the stream gravels, the gold deposits which may be of value are not placers, but occur in bed rock. The principal of these is in the altered Monte Cristo diorite, forming a very low-grade gold ore, at the head of the Nabesna River. It extends over an area of several square miles and has been mostly staked, but not developed. Other occurrences of gold were found at various points in quartz veins and stringers contained in the slates and schists of the Nutzotin and Mentasta mountains.

SOUTHERN PARTY.

Mr. Gerdine landed at Valdes on April 8, and with two men and two horses made his way inland, reaching Copper Center on April 16. Here he found several members of Mr. Witherspoon's party in charge of the season's supplies for the southern field. A part of these he at once moved to Chistochina, a distance of 65 miles, for use late in the summer. This work being accomplished, he returned to Copper Center on April 23.

On April 27, with the aid of two men, Mr. Gerdine laid out a base line about 2,640 feet in length on the frozen river near Copper Center. This base was measured three times, and the mean of the measurements was accepted as sufficiently accurate for the work. From this base the distance between two points 13 miles apart was determined by triangulation. These two points were platted on a plane-table sheet and from them a triangulation network was expanded, upon which the topographic work depended. The latitude of the points was determined by astronomic observations near Copper Center. This latitude was checked and the longitude established by connecting through plane-table triangulation with positions determined by a traverse line carried from Valdes into the interior during the season of 1900.

On June 3, after trips had been made to the Tonsina, the Klutina, the Tazlina, and down the Copper for the purpose of expanding from the Copper Center base, the entire party of eight, with nine pack animals, left Copper Center and established a new base camp near the foot of Nadina Glacier, about 16 miles to the east. The topographic and geologic work in the vicinity of Mount Drum was prosecuted from this new base while the supplies were being brought forward and cached here.

On June 13 the party broke camp and, leaving the greater part of their supplies on the Nadina, traveled in a southeast direction, mapping and investigating the area drained by the streams that have their sources on the southwest slopes of Mounts Drum and Wrangell, whence they flow into the Copper River. Work in this direction was continued until the Chetaslina River was reached on July 1, where the party was divided, Mr. Mendenhall, with two assistants and pack horses, extending his investigations into the Kotsina Basin, while Mr. Gerdine with the remaining force returned to the Nadina River base and began carrying the topographic work northward, around the western flanks of Mounts Drum and Sanford, toward the upper Copper River.

Meanwhile Mr. Mendenhall, having crossed from the Chetaslina River to the upper Kotsina and Elliott Creek valleys, examined there copper occurrences and developments which it had been impossible for Messrs. Schrader and Spencer to study during their reconnaissance of 1900. A week was spent at this work, and on its completion the geologic party started back and rejoined the main party, in charge of Mr. Gerdine, July 17, near the Sanford River. From this time until the end of the season the geologic and topographic divisions remained together.

On August 2, the work south of the Copper having been completed, the river was crossed above the mouth of the Slana, and after a hurried trip to Chistochina, to replenish the supplies from the cache made there in the spring, operations were resumed in the basin of Indian

Creek. From the source of this stream the route lay through a low pass into Mankamen Valley. Thence the party worked in a northwest direction, and mapped during the remainder of August and early September an area south of the Alaskan Range, drained by the headwaters of the Slana, Chistochina, Gakona, and Gulkana rivers, and including the Chistochina gold field.

By the time the party reached the source of the Delta the season was well advanced and continued snowstorms greatly interfered with work, so that on September 10 the return trip was begun. The surveys were continued, however, as far as the Chistochina River, where the summer's work ended. The party reached Chistochina post-office on September 15, and thence traveled by the Government trail to Valdes, where it arrived on September 27.

Mr. Gerdine's work resulted in the complete mapping of an area of about 4,500 square miles lying in the central and northern parts of the Copper River Basin. Concerning much of this territory there was no previous information, and over the remainder the topographic data were of the most meager description. The area includes the greater part of the active volcanic peak, Mount Wrangell, all of Mount Drum, and the southern and western slopes of Mount Sanford, the heights of all these peaks being determined. In addition, the southern face of the western extension of the Alaskan Range, the Chistochina gold field, and a large part of the Copper River Basin, with drainage ways and trails, were accurately mapped.

The maps which have been drawn as a result of this work, in addition to delineating a most interesting region geographically, have great economic value, since they show the routes to important economic regions, routes over which mail and telegraph lines are already established, and which perhaps in the near future will be followed by railroad lines.

Except for the short trip made to the Kotsina Valley in July, Mr. Mendenhall worked continuously from Mr.

Gerdine's camp, and the scope of his areal geologic mapping corresponds in general with that of the topographic. The geologic history of the southern part of the field, about the flanks of the Wrangell Mountains, is wholly different from that revealed in the region north of the Copper River. The geologic conditions in the Chitina Valley worked out by Schrader and Spencer in 1900 were found to extend but little west of the area which they studied. Beyond this, to the west and north, there must be considered the volcanism, glaciation, erosion, and Pleistocene history of the region, and also a few isolated areas of old schistose rocks of obscure origin, affected by massive intrusives. All possible data were gathered on all the purely geologic problems involved, and in addition much attention was paid to the copper deposits of the region and to the reputed occurrences of other economically important minerals.

The geologic results obtained in the northern part of the region may be briefly summarized as follows: That part of the Alaskan Range which lies immediately north of the Copper River Basin is made up principally of micaceous schists whose thickness and age are unknown. Immediately south of the schists, and separated from them by a fault whose throw probably exceeds 10,000 feet, is a belt of Permian beds extending east and west across the upper Chistochina Basin. These consist in the upper part of shales and limestones, but include at lower horizons arenaceous and tuffaceous sediments and flows, the total thickness being 6,000 or 7,000 feet. Many basic igneous masses occur as dikes or intrusive sheets in these sediments. They are especially abundant near the fault. Eocene lignite-bearing beds occur here and there in small patches infolded with the Permian, and in one large area just east of the Gakona Glacier.

South of the Permian belt lies a complex terrane of older rocks, consisting of conglomerates, quartzites, tuffaceous beds, and probably flows, which appear to be faulted against the Permian. This terrane is intruded

and altered by dikes and greater masses of granite and quartz-porphyry. One effect of the intrusion and alteration is a general impregnation by pyrite, whose oxidation products color the rocks rust-red and render them especially conspicuous.

Southeast of the Permian belt, in the valleys of Indian Creek and of the western tributaries of the Slana River, a large area of quartz-diorite occurs and gives rise to a region of rugged hills. Other igneous types and metamorphosed sediments make up the greater part of the smoother isolated hills rising from the Copper River Plain, in the basins of the Gakona, Gulkana, and middle Chistochina rivers.

In addition to these early separable consolidated rock masses, unconsolidated clays and gravels, either primarily or secondarily of glacial origin, occur in the valleys generally. Near the sources of the streams these deposits are confined to flood plains or narrow bordering terraces, but downstream the area covered by them widens until it merges with the broad drift-filled valley of the upper Copper Basin, from whose borders isolated bed-rock areas rise as islands.

Mr. Mendenhall also made an examination of the Chistochina placer field. This district, as far as developed, is limited to diggings on two streams, the Chesna River and Slate Creek, both tributary to the Chistochina River. His studies point to the conclusion that the gold has its source in local zones of metamorphism in the shales. The total production for the year 1902 is estimated at $225,000.

GENERAL RESULTS.

The topographic results secured by the excellent work done by Messrs. Gerdine and Witherspoon in 1902 may be summarized as follows: An area of between 9,000 and 10,000 square miles, much of it in a ruggedly mountainous country and including territory of actual and prospective economic importance, has been mapped on a scale of 1:250,000, with contour intervals of 200 feet. The maps

show the important region of the passes from the Copper to the Tanana and Nabesna drainage systems, and from the latter to the Chisana and White River basins. These maps, in connection with those prepared as a result of the work done by Messrs. Gerdine and Witherspoon in 1900, give practically complete topographic data for the Copper River Basin and the great group of the Wrangell Mountains. An interesting feature is the determination of the positions and altitudes of a number of the peaks of the latter. The heights, in feet, of the more important summits are as follows: Mount Sanford, 16,208; Mount Jarvis, 12,300; Mount Wrangell, 14,005; Mount Drum, 12,000; Mount Blackburn, 16,140; Mount Regal, 13,400.

The investigations of Messrs. Schrader and Mendenhall have thrown much light on the mineral resources of the Copper River region. The existence of two copper-bearing belts has been established, the one lying south and the other north of the Wrangell Mountains. The southern belt promises to be of economic importance, while the indications in the northern belt are less favorable as to future values. The Chistochina gold fields have been examined in some detail. The economic results have been elaborated in the office and are now in print under the title "The Mineral Resources of the Mount Wrangell District," by Walter C. Mendenhall and Frank C. Schrader, being Professional Paper No. 15. An abstract of this paper has already appeared in Bulletin No. 213.

Besides its economic results, the season's work has made marked geographic and geologic contributions to our knowledge of this important region, and has furnished the data requisite for constructing a practically complete map of the Copper River Basin, whose economic resources and railroad facilities have been attracting much attention during the last few years. The more general geologic and physiographic problems are at present the subject of study and will be presented for publication as soon as possible.

MOUNT M'KINLEY REGION.

In making plans for Alaskan surveys two objects are constantly kept in view—the investigation of areas of known mineral importance and the extension of general exploration work over the Territory, for the purpose of obtaining complete geographic and geologic knowledge and possibly of finding new mineral-producing areas. The work in the Mount McKinley region was undertaken with the second object in view. Its purpose was to make an exploration and survey of one of the largest unexplored tracts lying south of the Yukon. This area possesses special interest because it includes two of the highest peaks on the continent, and plans for its survey were under consideration four years ago. It was then deemed impracticable, because of the inaccessibility of the region, to make surveys through this belt in a single season; but accumulated experience in Alaskan surveys led to a change of view, and plans were formulated and successfully executed last summer.

The leadership of the party was intrusted to Mr. Alfred H. Brooks, geologist, and Mr. D. L. Reaburn was detailed as topographer. Mr. L. M. Prindle was engaged as geologic assistant, and Mr. Odell Reaburn as recorder. Fred Printz and W. W. von Canon were employed as packers, and George Revine as cook. Mr. Brooks being detained in Washington by office duties, the purchase of the horses and outfit was intrusted to Mr. Reaburn.

The party of 7 men, with 20 horses, embarked at Seattle on the 15th of May, and on the 27th of May were landed at Tyonok. Several days were spent at that point in repacking provisions and outfit, breaking the horses to pack saddles, and attempting to gather information from Indians, prospectors, and traders. In this attempt no great degree of success was attained, for the current knowledge of the inner region by the people of the coast settlements is usually very limited. Neither whites nor natives could be induced to believe that the plan formulated could be successfully carried out in the limits of one

season. After weighing all the evidence and making a few preliminary reconnoitering trips, it was decided to follow a route which would cross the Beluga River near its mouth and the Skwentna River near the lower canyon. In accordance with this plan, two men were engaged to take a boat load of supplies up the Sushitna and its west fork, the Skwentna River, to meet the party.

The party, having completed its preparations, was enabled to leave Tyonok on the 2d of June. The supplies consisted of one hundred and five days' rations for seven men, and the equipment included three carbines, one folding boat, four tents, sleeping bags, instruments, cooking utensils, tools, and personal belongings of the members of the party. The aggregate weight of the provisions and supplies was about 3,500 pounds, and of these about 1,000 pounds was sent by boat, while the remainder, together with 200 pounds of grain for the stock, was distributed among the 20 horses. Eighteen of the horses were equipped with sawbuck pack saddles, one with a combination saddle, and another with a Mexican riding saddle, but all carried packs throughout the season unless incapacitated by physical weakness.

Leaving Tyonok, the route lay along the gravel beach to the Beluga River, where, with the aid of a boat, a crossing was made without difficulty. At this point a delay of two days was caused by a trip to Mount Sushitna, which was occupied for the purposes of the topographic work. From Mount Sushitna the first sight of Mount McKinley and Mount Foraker was obtained, which, however, are visible from the coast on clear days. These peaks, though about 120 miles distant, towered far above the crest of the Alaskan Range and conveyed impressions of tremendous height. The party reassembled at the Beluga River and started inland on June 7. For about 50 miles an old Indian trail was followed, which lightened the work of trail chopping to a great extent. The Skwentna River was reached on June 18, and here an attempt was made to find a ford. This was unsuccessful, as both horses and riders were swept downstream by the

rushing current. The attempt to traverse the river at this point proved that it could be done only with serious danger of loss of equipment, if not of men and horses, and it was decided to turn downstream and meet the boat with the entire party. On June 21, after three weary days of trail chopping, the party reached the lower canyon and found the boat with supplies. Here the crossing proved feasible with the aid of the boat. From the Skwentna River the party headed northward through a flat, heavily timbered region, where almost continuous trail chopping was necessary. On the 28th the Keechatna River, also belonging to the Sushitna drainage, was reached, and here the men and boat again met the party.

The party had now used nearly a third of the season and accomplished less than one-sixth of the distance. The swampy region which had been traversed had weakened the horses, which were losing vitality, because they were both day and night almost continuously harassed by horseflies and mosquitoes. Moreover, there had been an outbreak of distemper among the horses, which at one time threatened to be very serious. In view of the uncertainty of progress during the remainder of the season, an emergency cache of a week's provisions was established at this point.

On June 30 the boat was sent back to the coast and the party, with horses, took up its march westward up the Keechatna River. The headwaters of this stream were attained on July 12, and on the 15th the party discovered a pass, called Rainy Pass, and crossed the watershed of the Alaskan Range. After traversing the range the route lay down the valley of the Kuskokwim for about 30 miles, to the front of the range, and then turned northeastward. For about 200 miles from this point the course lay in a northeasterly direction, along the base of the mountains, which fall off abruptly to a gravel-floored plateau dissected by numerous streams and river valleys. This plateau, which is for the most part above timber, afforded excellent travel for men and horses, and progress

was rapid. Grass was abundant, and sufficient willow for fuel was always found. The only obstacles were the numerous turbulent rivers, whose fording was always undertaken with danger. The many caribou on the plateau, the mountain sheep in the mountains, and the moose in the river valleys afforded an abundance and a variety of fresh meat. Two horses were exhausted by the strain of the first month and had to be shot.

On August 4 a camp was made which was only 14 miles by air line from Mount McKinley, the highest peak on the continent. Here a day's delay permitted the geologist to climb the slopes of the mountain to snow line and to obtain some clue to its geologic structure. Northeast of Mount McKinley the range swings eastward, and the route, still continuing to follow the base, took a similar change of direction. For 100 miles there was little change in the character of the topography, and rapid progress continued to be made. On August 15 camp was made in the valley of the Cantwell River, a tributary of the Tanana. This river was followed upstream to its main fork, where a ford was found, and the last dangerous crossing of the season was then accomplished. The left fork of the Cantwell was followed nearly to its glacial source, and then, crossing it in a northwesterly course, the party entered the Tanana Valley after traversing the mountains which separated the two valleys.

On August 24 a white man and a band of Indians were encountered, the first human beings seen in nearly three months. From this point an Indian trail led the party to the Tanana River, which was reached at a small native settlement called Tortella. With the aid of a boat secured from the Indians, the Tanana was crossed without difficulty. The route then lay to the northwest, toward Rampart, on the Yukon. The horses at this time began to show the effects of the long trip, and their packs were reduced as far as possible by abandoning all except the most necessary part of the equipment. For two days

the route of travel followed a series of low ridges, to the north of which stretches the lowland of the Tolovana River. This lowland, partly thickly timbered, partly swampy, dotted with innumerable lakes, and traversed by many sluggish streams and rivers, had been reported by the Indians as impassable for horses. After skirting the southern border of this lowland for 20 miles, the route was changed to northwest, directly across it. The traversing of the lowland proved difficult and time consuming. The delay was caused chiefly by time spent in building corduroy, bridging streams, and rafting rivers. In the course of six days five bridges were constructed and four rivers were rafted. On the 9th of September the low country was left behind, and from this point on to the Yukon the route lay through an upland region. At this time the horses began to fail at an alarming rate. Though their loads were light, the frost-bitten grass and the hard traveling through the swamps had a disastrous effect upon all except the strongest. During the rest of the journey one or more horses were shot nearly every day. On the 14th Little Minook Creek was reached, from which a horse trail led to Rampart, on the Yukon, which was reached on the 15th. On the 16th a river steamer was boarded for St. Michael, and thence the party returned to Seattle, which was reached on the 30th. In one hundred and five days the party had traveled about 800 miles, and during this time 94 camps had been made. Eleven out of the 20 horses reached Rampart.

In spite of the rapid movements of the party, Mr. Reaburn, by his untiring activity, was enabled to carry a continuous plane-table survey throughout the journey, extending from Cook Inlet to the Yukon. Approximate altitudes were determined by vertical angles, and plane-table work was frequently checked by altitude and azimuth determinations. This survey embraces not only a thoroughly accurate location of the route, but also includes a considerable area of topography on both sides, aggregating in all about 10,000 square miles.

The chief geographic results of the expedition are the mapping of the western front of the Alaskan Range to the headwaters of the Kuskokwim and the connection of the four previous exploratory surveys which had been made in the region. All these surveys are now tied together, and can be mutually adjusted. The position of Mount McKinley was more accurately determined; also its altitude, which is 20,300 feet. Mount Foraker, about 15 miles south of Mount McKinley, was also located, and its altitude was determined to be 17,100 feet. While the actual surveys include only 10,000 square miles, the information obtained and the correlations and connections between previously surveyed areas throw additional light upon the geography and topography of an area of probably 50,000 square miles.

The geologic work in the region was of a reconnaissance character, but developed some facts of importance which promise to throw light upon the stratigraphic problems of Alaska. The oldest terranes were found in the northern part of the area, and consist of a metamorphic conglomerate, often having a gneissic phase. The lowest member of this series is not distinguishable from a true Archean gneiss and may be part of a crystalline basal complex. Overlying the conglomerate a slate and phyllite series was found, succeeded by limestones and slates and arenaceous beds carrying some Ordovician fossils. Devonian limestones were found to be widely distributed. The Paleozoic rocks are intensely folded and faulted. At least one, and probably two, unconformities occur within the Paleozoic, one near the base of the Devonian and a second probably in the Silurian.

In the southern part of the area there is a vast thickness of shales, slates, grits, and sandstones, in which Jurassic fossils were found. These were well exposed in the section studied along the route of travel, where the range was crossed. Northward this series thins out, and near the Tanana is entirely wanting, and it is overlain unconformably by sandstones, conglomerates, and shales, which carry coals. The plant remains from these beds, studied

by Mr. F. H. Knowlton, show them to be of Arctic Miocene or Eocene age. These Tertiary beds have a limited development in the southern part of the belt, but thicken northward. On the Cantwell a section of 3,000 feet was measured. The only other consolidated beds noted in the region were some friable lignitic sandstones, which were found in the southern part of the belt. These seem to aggregate not over 200 feet, and are probably of Tertiary age.

Igneous rocks are very plentiful. There are two important lines of granitic intrusion, one east of the mountains, along the axis of the Sushitna Valley, and a second along the axis of the Alaskan Range. The highest peaks of the range, such as Mount McKinley and Mount Foraker, are probably made up chiefly of granite. Various other granular rocks occur as dikes and stocks. Extrusive rocks are found along both flanks of the range, but do not seem to compose the range itself. The volcanics are mainly Tertiary (post-Eocene). The active volcanoes of the Aleutian Islands and the Alaska Peninsula do not extend into the region under discussion, though some of their ejecta are mingled with the recent alluvial deposits.

Evidence of glaciation is abundant in the region south of the Tanana Valley. Glacial till and erratics were found along the western shore of Cook Inlet, and are closely associated with stratified sands and gravels. The foothills, 2,000 feet high, 40 miles inland, are glaciated, and farther west, in the mountains, the upper limit of glaciation was found at an altitude of about 4,000 feet. The base of the mountains is glaciated; likewise the valleys up to 4,000 or 5,000 feet. On both sides of the range there are heavy gravel deposits, which mantle the base of the mountains. These are interpreted as overwash deposited during the retreat of the ice. Remnants of this greater ice sheet may be seen in the glaciers that now occupy many of the higher valleys on both sides of the mountains.

The value of this survey, as has been shown, lies chiefly in its geographic and geologic results, for the

region traversed possesses little mineral value. The gravels which form the terraces on the west side of Cook Inlet are in places auriferous, but it is doubtful whether their gold content is in any instance sufficient to pay for exploitation, even by hydraulic methods. The streams crossed by the party in the foothills northwest of Cook Inlet were found to carry some gold, but their prospective value is very doubtful. The western margin of the Alaskan Range, as far as could be determined, does not carry placer gold. Some high gravel benches along the southern wall of the Tanana Valley were found to carry some fine gold. Under present conditions the location of these gravels precludes their being of commercial importance, though it is possible that with transportation facilities for heavy machinery they might carry hydraulic values.

Some lignites were examined on the west shore of Cook Inlet, and also on the Keechatna River, but these are of an inferior grade. Coals of a better class occur in Tertiary sandstone on the upper Cantwell River. These, if they were on a transportation route, could undoubtedly be mined at a profit. A short description of these coals was prepared by Mr. Brooks for inclusion in Mr. Collier's report entitled "Coal Resources of the Yukon," which is now in press as Bulletin No. 218.

Mr. Reaburn compiled his field notes soon after his return to the office, and prepared a map on a scale of 1:625,000. He also wrote a brief statement in regard to the methods employed in the Alaskan topographic surveys, which is to be included in the report on the results of the expedition.

Mr. Brooks's time has been so largely taken up with the administrative work of the division that he has found it impossible to complete his report before again taking the field. He expects to submit it soon after his return. In response to a popular demand for information regarding Mount McKinley, Messrs. Brooks and Reaburn published an article entitled "Plan for Climbing Mount McKinley," in the National Geographic Magazine for January, 1903.

Mr. Brooks also wrote an article on "Placer Gold Mining in Alaska in 1902," published in Bulletin No. 213. A more important piece of work has been completed by him, entitled "The Geography of Alaska," and has been submitted for publication as a professional paper.

COAL RESOURCES OF THE YUKON.

Mr. Arthur J. Collier, assistant geologist, was detailed to investigate the coal resources of the Yukon River, to study the stratigraphy of the geologic section along its banks, and to make paleontologic collections. Mr. Collier, with Sidney Paige and Charles Kronholm, camp hands, reached Dawson June 12, where a camping outfit, including a rowboat and a canoe, was procured. On June 15 the party proceeded down the Yukon in boat and canoe, carrying on investigations in some detail at a number of points for 1,300 miles along the river. At Pimute, an Indian village about 100 miles above the delta, owing to stormy weather, the work was closed, and on September 15 the party took steamer for St. Michael. The studies were largely confined to the river banks, but a few side trips were made. The Fortymile River was ascended for about 20 miles to enable the geologist to become familiar with the types of rocks there exposed. The coal beds, which lie about 10 miles northeast of the Yukon, on Coal Creek, were hastily examined. Three days were spent in an investigation of the coal basin lying about 12 miles south of the Yukon, in the Washington Creek Valley. The latter stream is an easterly tributary of the Yukon about 80 miles below the international boundary. The gold placers on Woodchopper Creek, 6 miles from the Yukon and about 100 miles below the international boundary, were examined.

At Rampart the camp remained five days, while the geologist made a hasty trip to the Glenn Creek mining camp, which lies within the Tanana River Basin, and about 30 miles south of Rampart. These placers were discovered in 1901, and previous to August, 1902, had produced about $150,000 in gold. About 35 miles below the

Melozi another side trip was made, southward. This was to determine the southern boundary of a large area of coal-bearing beds which outcrop along the Yukon almost continuously from the Melozi to the head of the delta. On this trip a small stream called the Klalishkakat was ascended until the older rocks were reached. Colors of gold were found in the gravels of this creek.

During the three months' field season all the coal mines and known prospects accessible from the Yukon were examined. Samples of coal were collected from them, analyses of the more important of which have been made by Mr. E. T. Allen in the chemical laboratory of the Survey. The results of this examination have been submitted for publication in a bulletin (No. 218) entitled "Coal Resources of the Yukon." An abstract of this paper has already been published in Bulletin No. 213. The results of the examination of the placers on Glenn Creek south of Rampart have been published under the title "The Glenn Creek Gold-Mining District, Alaska," in Bulletin No. 213.

The scientific results of these studies have not yet been formulated, and their publication will be deferred until further investigations have been made. They show that on the upper Yukon there are Lower Carboniferous and Devonian horizons which have not heretofore been recognized, and that on the lower Yukon there are both Lower and Upper Cretaceous fresh-water beds and Upper Cretaceous marine beds which had not been previously described. Though the studies were carried on in considerably more detail than any that preceded them, they could not lead to final conclusions in regard to the stratigraphic sections on the Yukon. While they have thrown much new light on some of the vexed questions of Yukon stratigraphy, they have also raised a number of new questions and shown the need of more extended work in the same region.

No complete instrumental survey of the Yukon has yet been made, and no accurate map has been published. In the course of the present investigation a traverse and

sketch of the river by compass azimuth and estimated distances were made by Mr. Sidney Paige under Mr. Collier's direction. This traverse will afford material for the compilation of a new map of the Yukon, which will be better than any hitherto published.

TOPOGRAPHIC SURVEY IN JUNEAU REGION.

Mr. W. J. Peters, topographer, was assigned to the duty of mapping an area in the vicinity of Juneau, including a portion of Douglas Island.

The party was organized at Seattle and sailed on May 29 for Juneau, which was reached on June 2. Mr. Peters was delayed somewhat in starting his plane-table work by difficulty experienced in recovering triangulation stations which had been established by the Coast and Geodetic Survey many years ago. A sufficient number, however, were ultimately identified to admit of the expansion necessary to control the topographic mapping.

Plane-table work was commenced on June 23 and completed on November 1, the area mapped being 100 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. On account of fog and rain the season was exceptionally unfavorable for plane-table work. Photographs were taken with a photographic theodolite, a combined instrument loaned by the Coast and Geodetic Survey, to test the efficiency of this method of surveying in southeastern Alaska. The party returned to Seattle on a steamer leaving Juneau on November 5. During the course of the winter Mr. Peters completed the drawing of this map, which has been submitted for publication as a topographic sheet under the name "Juneau Special." This map is intended as a base for detailed geologic investigation of the region.

SEASON OF 1903.

The Alaskan investigations have met with the approval of the mining public, but unfortunately they can not keep pace with the rapid development of the mineral resources of the Territory. In the last ten years the value of the

product from quartz mines has nearly doubled, while the gold placers have increased their output from about $200,000 to over $6,000,000. Mining and prospecting is being actively pushed in nearly all parts of the Territory, and there are ten times more demands made on the Geological Survey for mapping and investigations than can be met under the present appropriations. The more urgent work can be grouped under three heads: First, the completion of the exploration and general mapping of the Territory. Only about a fifth of the area of Alaska has been surveyed in even a preliminary way, and at the present rate of progress this task can not be completed under ten years. Meanwhile, until river courses have been surveyed and mountain passes explored, miners, prospectors, settlers, and traders are working blindly and are annually spending more than the cost of the surveys of the entire Territory.

The second great need is for the reconnaissance of the important mining districts, which has been only in part completed. Even a hasty examination of a mining district often enables the geologist to point out some of the laws which govern the occurrence of the metalliferous deposits. Work of this character which has been done has been greatly appreciated by the Alaskan prospector.

The third demand is for detailed studies of the mining districts, which are especially desirable in regions of underground mining. This work, which is necessarily slow and expensive, has only this season been inaugurated in the Juneau region. It is very unfortunate that such studies can not be pushed more rapidly, as there are a dozen or more other localities where there is an equal demand for this class of investigations.

In planning the work for the season of 1903, attempt was made to meet the more pressing demands, and with this in view seven parties were put in the field. Of these two are in the Nome region, two are in the Tanana-Yukon region, one is investigating the coal-bearing rocks of the Yukon, one is in the petroleum fields of the Pacific

coastal belt, and the seventh is in the Juneau and adjacent mining districts.

Nome region.—Mr. Arthur J. Collier, assistant geologist, with the assistance of Mr. Frank Hess, was instructed to make a supplementary investigation of the Nome gold fields, in which special attention should be paid to the developments of the last two seasons. He spent the month of June in the Nome region proper, and later will visit other districts of the Seward Peninsula.

Mr. D. C. Witherspoon, assistant topographer, with Mr. F. H. Moffit, assistant geologist, was detailed to survey and investigate the northeastern part of the Seward Peninsula. Their field will embrace the Candle Creek and other placers. It is hoped that this party will be able to complete the reconnaissance mapping of the peninsula.

Yukon region.—Mr. T. G. Gerdine, with one assistant and a number of camp hands, began topographic mapping near Eagle, on the Yukon, about the middle of June. He was instructed to extend a survey to the southwest, including, if possible, the Chena gold field near the Tanana.

Mr. L. M. Prindle, special assistant, during the latter part of June was engaged in a study of the placer fields of the Fortymile region. He is to take up an investigation of the Birch Creek and Chena placers later in the season.

Mr. Arthur Hollick, assistant geologist, with Mr. Sidney Paige, assistant, was detailed to study the Mesozoic and Tertiary stratigraphy along the Yukon, with the special view of determining the age of the coal-bearing horizons.

Controller Bay and Cook Inlet oil fields.—Mr. George C. Martin, special assistant, was assigned to the task of making a reconnaissance of the Controller Bay and Cook Inlet oil fields. Hundreds of thousands of dollars are being spent in these fields, and there is an urgent demand for detailed investigations, but unfortunately lack of funds prevented anything more than a hasty examination during the season. Mr. Martin left Seattle in early June,

and spent the greater part of that month in the Controller Bay field.

Southeastern Alaska.—Mr. Arthur C. Spencer, aided by Mr. Charles W. Wright, will spend most of the summer in mapping the areal geology and studying the ore deposits of the Juneau region. He will also make a hasty examination of some of the other districts of southeastern Alaska.

Mr. Wright spent a part of the month of June in reconnoitering the placer field of Porcupine, near the international boundary. Later he will join Mr. Spencer at Juneau.

Administrative work.—Mr. Brooks has spent nearly three-fourths of his time in office on the administrative work of the division, which involves a constantly increasing correspondence with mining men interested in Alaska. He will take the field about the middle of the summer and visit the Spencer party at Juneau, the Gerdine and Prindle parties on the Yukon, and the Collier party at Nome.

Division of Mining and Mineral Resources.

The principal work of this division is the preparation of the annual report on the mineral resources of the United States, although considerable time is devoted to answering technical inquiries. During the year the report on the mineral resources of the United States for 1901 was issued, and considerable progress was made on the report for 1902, the following chapters having been published as advance pamphlets: American Iron Trade, Antimony, Aluminum and Bauxite, Bismuth, Graphite, Bromine, Arsenic, Salt.

At the request of the Director of the Census, the schedules of inquiry of the Twelfth Census in regard to mining were inclosed with the statistical cards annually sent out by this office. The returns were transmitted through the Geological Survey to the Census Office, thus affording both offices the benefit of cooperation. This work was nearly complete at the end of the fiscal year.

A paper outlined in the last report, entitled "Coal Fields of the United States," was completed and published in the Twenty-second Annual Report, Part III. During the year a bulletin on the gypsum deposits of the United States, by Mr. George I. Adams, was in preparation by this division and the section of economic geology of nonmetalliferous minerals.

In addition to the regular agents and field assistants who aided in the work, Mr. David T. Day, geologist in charge, was assisted by Mr. Edward W. Parker and Mr. Jefferson Middleton, statisticians; Mr. William Taylor Thom, editorial clerk; Miss Josephine B. Claggett, Miss Katrine W. Cottrell, Miss Helen M. Hough, Mrs. Lotta L. Kimball, Miss Lida Mann, Mrs. Mary M. Raborg, and Miss Laura E. Thorwarth, clerks; Miss Belle W. Bagley, Miss Altha T. Coons, Miss Julia M. Corse, and Mr. Theodore Johnson, statistical experts; and Miss Elizabeth A. Balloch, Miss Martha B. Clark, Miss Eva E. Evans, Miss Elsie L. D. Patterson, and Miss Helen L. Stoddard, stenographers.

In 1902, for the third time, the total value of our mineral production exceeded the enormous sum of $1,000,000,000. This valuation of the commercial mineral production of the United States for 1902 is not increased by the excess of the value of the crude product mined, as reported by the Census, over the marketed products, as for example in the case of phosphate rock, nor is it diminished by the difference of value between the commercial product and the crude product as reported by the Census, though both differences, where they occur, are noted in the text. The exact figures for 1902 were $1,244,918,422, as compared with $1,086,529,521 in 1901, with $1,063,620,548 in 1900, and with $972,152,208 in 1899, a gain of 1902 over 1901 of $158,388,901, or 14.58 per cent; a gain of 1902 over 1900 of $181,297,874, or 17.04 per cent, and a gain of 1902 over 1899 of $272,766,214, or 28.06 per cent. Although this gain is not so great either actually or proportionally as was the gain in 1899, when the gain over 1898 was $273,601,810, or 39.17 per cent, it is sufficient to be worthy of note.

The notable gains and losses of the last two decades are as follows:

The largest actual gain was that of 1899 over 1898, $273,601,810, or 39.17 per cent; next, that of 1902 over 1901, $158,388,901, or 14.58 per cent; then that of 1900 over 1899, $91,468,340, or 9.41 per cent; then the gain of 1895 over 1894, which was $94,215,822, or 17.88 per cent, and the gain of 1887 over 1886, $74,927,880, or 16.81 per cent. In other years than those mentioned between 1880 and 1898 the gains were not noteworthy, and in some of the years, notably in 1884, the production decreased $40,451,968, or nearly 9 per cent. During the industrial depression of 1892–1895 the production would have been expected to decline, as it did, going from $648,895,031 in 1892 to $574,464,724 in 1893, and to $527,079,225 in 1894, and then rising to $621,295,047 in 1895, and not reaching the output of 1892 until 1898.

As heretofore, iron and coal are the most important of our mineral products. The value of the iron in 1902 was $372,775,000; the value of coal, $371,729,098. Nearly all the important metals increased in both output and value; and among the less important metals platinum, as compared with 1901, lost in both quantity and value even more than it gained in 1901 as compared with 1900, the production in 1902 being 94 ounces, valued at $1,814, as compared with 1,408 ounces, valued at $27,526, in 1901, with 400 ounces in 1900, and with 300 ounces in 1899. The fuels increased from $442,395,304 in 1901 to $473,465,680 in 1902, a gain of $31,070,376, or 7.02 per cent. Every variety of fuel increased in value except anthracite coal, which showed a decrease in quantity of 23,376,850 long tons and in value of $31,487,083. The average price of anthracite coal per long ton at the mine was $2.50, as against $2.05 in 1901—the highest figure then obtained since 1888—as compared with $1.85 in 1900, and with $1.80 in 1899; and the average price per ton for bituminous coal at the mine was $1.125, as compared with $1.047 in 1901. The increase in value of the bituminous coal output over 1901 was $55,710,457.

The gain of $144,814,529 in the total value of our mineral production is due to the increase in both metallic and nonmetallic products, the metallic products showing an increase from $518,268,377 in 1901 to $642,291,148 in 1902, a gain of $124,022,771, and the nonmetallic products showing an increase from $567,261,144 in 1901 to $601,627,274 in 1902, a gain of $34,366,060. To these products should be added estimated unspecified products, including building, molding, and other sands reported to this office, the rare mineral molybdenum, and other mineral products, valued at $1,000,000, making the total mineral production for 1902, $1,244,918,422.

For the second time the manufacture of arsenious oxide, noted for the first time in the United States in the report for 1901, was continued in increased proportions.

METALS.

Iron and steel.—Twenty-two States made pig iron in 1902, as against 21 in 1899 and 1900, and 20 in 1901. The total production of pig iron in 1902 was 17,821,307 long tons, against 15,878,354 tons in 1901, 13,789,242 tons in 1900, 13,620,703 tons in 1899, 11,773,934 tons in 1898, and 9,652,680 tons in 1897. The production of 1902 shows an increase of 1,942,953 long tons, or 12.2 per cent, in quantity, over the production of 1901, and an increase in value from $242,174,000 to $372,775,000, amounting to $130,601,000, or about 54 per cent. The average price per long ton of pig iron increased from $15.25 in 1901 to $20.90 in 1902. The average prices per long ton in recent years have been as follows: 1900, $18.85; 1899, $18; 1897, $9.85; 1896, $10.47; 1895, $11.14; 1894, $9.76.

Iron ores.—The production of iron ores in 1902 amounted to 35,269,200 long tons, as compared with 28,887,479 long tons in 1901, a gain of 3,534,813 long tons. The value at the mines of the ore mined in 1902 was $65,055,185. As in the four preceding years, the production of iron ores in 1902 has never been equaled by any other country.

Copper.—The copper-mining industry suffered during 1902 from the reaction which followed the unsuccessful attempt in 1901 to maintain the metal at an artificial level.

The production, however, increased from 602,072,519 pounds in 1901 to 659,508,644 pounds in 1902, an increase of 57,436,125 pounds, or about 9 per cent, in quantity, but decreased in value from $87,300,575 in 1901 to $76,568,954 in 1902, a decrease of $10,731,561, or about 12 per cent. Unless unforeseen events cause widespread or long stoppage at the mines, the production of copper in the United States will be considerably larger in 1903 than it has ever been.

Lead.—The production of lead has been almost exactly the same for the last three years, viz, 270,000 short tons in 1902, 270,700 short tons in 1901, and 270,824 short tons in 1900. The value of the production in 1902 was $22,140,000, as compared with $23,280,200 in 1901, and with $23,564,688 in 1900.

Zinc.—The production of zinc in 1902 showed a continued increase in quantity as compared with 1901 and 1900, the production being 156,927 short tons in 1902, as compared with 140,822 short tons in 1901 and with 123,886 short tons in 1900. The value of the zinc production in 1902 was $14,625,596, as compared with $11,265,760 in 1901, and with $10,654,196 in 1900.

Gold.—The production of gold in 1902 amounted to 3,870,000 fine ounces, as compared with 3,805,500 fine ounces in 1901, and with 3,829,897 fine ounces in 1900. The value was $80,000,000, as compared with $78,666,700 in 1901, with $79,171,000 in 1900, and with $71,053,400 in 1899.

Silver.—The coining value of the silver produced in 1902 was $71,757,575, as compared with $71,387,800 in 1901, and with $74,533,495 in 1900. The production in 1902 was 55,500,000 fine ounces, as compared with 55,214,000 fine ounces in 1901, and with 57,647,000 fine ounces in 1900. The commercial value of the production in 1902 was $29,415,000, as compared with $33,128,400 in 1901, and with $35,741,140 in 1900.

Quicksilver.—The production of quicksilver during 1902 amounted to 34,451 flasks of 76½ pounds net, as compared with 29,727 flasks in 1901 and with 28,317 flasks in 1900. The value of the quicksilver produced in 1902 was

$1,500,412, as compared with $1,382,305 in 1901 and with $1,302,586 in 1900. California reported 29,199 flasks in 1902, as compared with 26,720 flasks in 1901; and Texas reported 5,252 flasks in 1902, as againt 2,932 flasks in 1901.

Aluminum.—The production of aluminum during 1902 was 7,300,000 pounds, valued at $2,284,590, as compared with 7,150,000 pounds, valued at $2,238,000 in 1901, and with 7,150,000 pounds, valued at $1,920,000 in 1900.

Antimony.—No antimony was obtained from domestic ores during 1902. The antimony obtained from the smelting of foreign imported ores amounted to 657 short tons, valued at $129,126, and the antimony obtained from hard lead produced from foreign and domestic lead ores was 2,904 short tons, valued at $505,240, a total production for 1902 of 3,561 short tons, valued at $634,506, as compared with 2,639 short tons, valued at $539,902, in 1901. The estimated total amount of antimony available for consumption in 1902 was 6,255 short tons, including 2,694 short tons of imported antimony regulus, as compared with 4,475 short tons, including 1,837 short tons of imported antimony regulus in 1901, and with 6,053 short tons, including 1,827 short tons of imported antimony regulus, in 1900.

Nickel.—The commercial production of nickel in 1902 was 5,748 pounds, as compared with 6,700 pounds in 1901, with 9,715 pounds in 1900, and with 22,541 pounds in 1899. The value showed a corresponding decrease—from $8,566 in 1899 to $3,886 in 1900, to $3,551 in 1901, and to $2,701 in 1902. The imports of nickel in 1902 were valued at $1,437,649, as compared with $1,849,620 in 1901, and with $1,183,884 in 1900. The Census reports 25 tons of nickel and cobalt matte and concentrated nickel ore, valued at $8,800, produced in 1902.

Platinum.—The production of platinum from domestic ores in 1902 was 94 ounces, valued at $1,814, as compared with 1,408 ounces, valued at $27,526, in 1901, with 400 ounces in 1900, and with 300 ounces in 1899.

Bismuth.—No bismuth ores were produced in the United States during 1902. The marketed output in 1901 was 318.6 short tons. The ore contained gold and silver, for

which the producers were paid. As nearly as can be ascertained, the value of the output in 1901 was $80 per ton, not including charges for transportation or treatment.

Manganese ores.—The production of manganese ores increased from 11,995 long tons, valued at $116,722, in 1901, to 29,752 long tons, valued at $230,282, in 1902, an increase in quantity of 17,757 tons and in value of $113,560. The average price per ton was $7.74, as compared with $9.73 in 1901, and with $8.52 in 1900.

FUELS.

Coal.—For the first time in the history of the United States the production of coal reached a total of over 300,000,000 short tons, showing an actual output of 301,260,357 tons of 2,000 pounds, valued at $371,729,098. Of this total the output of anthracite coal amounted to 36,865,710 long tons (equivalent to 41,289,595 short tons), which, as compared with the production of 60,242,560 long tons in 1901, was a decrease of 23,376,850 long tons, or almost 40 per cent. This decrease, as is well known, was due entirely to the suspension of operations by the strike in the anthracite region from May 10 to October 23, a little over five months. But for the strike the output for the year would probably have been over 65,000,000 long tons. The value at the mines of the anthracite coal in 1902 was $81,016,937 as against $112,504,020 in 1901, a loss of about 27 per cent. The average value of the marketed coal sold during the year at the mines was $2.50 per long ton, the value in 1901 having been $2.05.

The output of bituminous coal (which includes semianthracite and all semibituminous and lignite coals) amounted in 1902 to 259,970,762 short tons, valued at $290,712,161, as against 225,826,849 short tons, valued at $236,406,449, in 1901. The increase in the production of bituminous coal was, therefore, 34,143,913 tons in quantity and $54,305,712 in value.

Out of 30 States and Territories producing coal in 1902, seven—California, Michigan, New Mexico, Oregon, Pennsylvania, Texas, and Washington—had smaller outputs than in 1901.

The production of bituminous coal in Pennsylvania in 1902 exceeded that of 1901 by 15,755,874 short tons, but was not sufficient to overcome the great loss in anthracite production. The States in which the more important increases occurred, with the corresponding gains, are as follows: Illinois, 5,547,751 short tons; Colorado, 2,314,-412 short tons; Ohio, 2,444,577 short tons; Indiana, 2,268,371 short tons; Alabama, 1,490,865 short tons; Kentucky, 1,193,176 short tons.

Coke.—The coke production of the United States in 1902 exceeded that of any year in our history. The production, which includes the output from 1,663 retort or by-product ovens, amounted to 25,401,730 short tons, as compared with 21,795,883 short tons in 1901, and with 20,533,348 short tons in 1900. The increase in 1902 over 1901 amounted to 3,605,847 short tons, or 16.5 per cent. Large as this increase was, it was considerably less than it would have been had the transportation facilities been commensurate with the demand for coke and with the productive capacity of the ovens. The increase in the value of coke was even more noteworthy. The average price per ton at the ovens was the highest recorded in a period of twenty-three years, and the total value reached the high figure of $63,339,167, an increase over 1901 of $18,893,244, or 42.5 per cent. The value of the coal used in the manufacture of coke in 1902 exceeded that of 1901 by $7,932,563, from which it appears that the value of the coke product increased $10,970,681 over and above the increased value of the coal used in its production. In 1901 the highest price obtained for Connellsville furnace coke was $4.25. In September and October of 1902, while the contract coke was nominally quoted at $3 per ton, consumers were paying from $10 to $12 per ton for prompt delivery, and $15 was reported as paid for this fuel at one time. With the termination of the anthracite strike in the latter part of October prices for coke quickly declined, but in December of 1902 furnace coke for prompt delivery was still commanding $5 and $6 per ton, and contracts for delivery in the first six months of 1903 were made at from $3.75 to $4 per ton.

Petroleum.—The total production of crude petroleum in the United States in 1902 was 88,277,310 barrels, as against 69,389,194 barrels in 1901, an increase of 18,888,116 barrels, or 27.4 per cent, over the production of 1901 and of 38.7 per cent over that of 1900. The greatest portion of the increase in 1902 came from Texas and California, the gain over 1901 being 11,295,227 barrels, or 189 per cent, for Texas and 5,187,518 barrels, or 59 per cent, for California. The increase in Indiana in 1902 over 1901 was 1,723,810 barrels, or about 30 per cent. Louisiana produced for the first time in 1902, the production being 548,617 barrels. The increase over 1901 in the production of Kansas was 152,598 barrels, or about 85 per cent. Kentucky and Tennessee increased their production in 1902 by 47,791 barrels, or nearly 35 per cent. Indian Territory increased 37,000 barrels and Montana 850 barrels as compared with 1901. The largest decrease in production in 1902 as compared with 1901 was in West Virginia, where it amounted to 663,781 barrels, or about 4.5 per cent, and Ohio in 62 fields showed a decrease of 633,852 barrels, or nearly 3 per cent. The decrease in Pennsylvania was 561,888 barrels, or about 7 per cent; in Colorado, 66,218 barrels, or about 14 per cent. The percentages of production for fields show a remarkable change from 1900 to 1902. In 1900 the percentages were: Appalachian field, 57; Lima-Indiana field, 34; all other fields, nearly 9. In 1902 the respective percentages were: Appalachian field, 39; Lima-Indiana field, 29; all other fields, about 32. The value of crude petroleum produced during 1902 was $70,981,625, or 80.4 cents per barrel, as compared with $66,417,335, or 95.7 cents per barrel, in 1901—a decrease of 15.3 cents per barrel, or 16 per cent, in 1902.

Natural gas.—The value of the natural gas produced in 1902 increased to $30,754,957, as compared with $27,067,500 in 1901, with $23,698,674 in 1900, and with $20,074,873 in 1899—a gain of 13 per cent in 1902 over 1901.

STRUCTURAL MATERIALS.

Stone.—The value of all kinds of building stone produced in the United States during 1902 amounted to

$63,057,478, as compared with $55,615,926 in 1901, with $44,321,345 in 1900, and with $44,090,670 in 1899.

Clay products.—The activity in all branches of the clay-working industries noted in the reports as true of 1899, 1900, and 1901 continued during 1902. The value of all clay products as reported to this office in 1902 was $122,169,531, as compared with $110,211,587 in 1901 and with $96,212,345 in 1900. The brick and tile products in 1902 were valued at $98,042,078, as compared with $87,747,727 in 1901 and with $76,413,775 in 1900; the pottery products were valued in 1902 at $24,127,453, as compared with $22,463,860 in 1901 and with $19,798,570 in 1900.

The commercial production of clay mined and sold by those not manufacturing the product themselves in 1902 was valued at $2,324,861, as compared with $2,576,932 in 1901 and with $1,840,377 in 1900. The Census reports also $7,177 worth of clay mined but not sold.

Cement.—The total production of hydraulic cement in the United States in 1902 was 26,471,774 barrels, valued at $21,585,332, as compared with 20,068,737 barrels, valued at $15,786,789, in 1901, and with 17,231,150 barrels, valued at $13,283,581, in 1900. The Portland cement production in 1902 was 16,924,460 barrels, valued at $15,020,810, as compared with 12,711,225 barrels, valued at $12,532,360, in 1901, and with 8,482,020 barrels, valued at $9,280,525, in 1900—an increase, as compared with 1900, in quantity of about 100 per cent and in value of over 50 per cent. The number of plants using Portland cement increased from 50 in 1900 to 56 in 1901, and to 65 in 1902. The production of natural-rock cement in 1902 was 9,068,759 barrels, valued at $6,138,850, as compared with 7,084,823 barrels, valued at $3,056,278, in 1901, and with 8,383,519 barrels, valued at $3,728,848, in 1900. The production of slag cement amounted to 478,555 barrels, valued at $425,672, in 1902, as compared with 272,689 barrels, valued at $198,151, in 1901, and with 365,611 barrels, valued at $274,208, in 1900.

ABRASIVE MATERIALS.

Carborundum.—There was a slight decrease in the quantity of carborundum—3,741,500 pounds produced in 1902 as compared with 3,838,175 pounds in 1901—due in part to lack of a sufficient supply of raw materials, a result of the anthracite coal strike. The value of the carborundum varies from 8 to 10 cents per pound.

Corundum and emery.—The combined production of corundum and emery in 1902 amounted to 4,251 short tons, valued at $104,605, as compared with 4,305 short tons, valued at $146,040, in 1901, a decrease of 54 tons in quantity and of $41,435 in value.

Crushed steel.—The production of crushed steel in 1902 was 735,000 pounds, as compared with 690,000 pounds in 1901, and the product is quoted at 5½ cents per pound free on board at Pittsburg.

Crystalline quartz.—In 1902 the production of crystalline quartz included under Abrasives amounted to 15,104 short tons, valued at $43,085, as compared with 14,050 short tons, valued at $41,500, in 1901. The actual value of the crude quartz produced varies from $2.50 to $5 per ton.

Garnet.—The production of abrasive garnet in the United States during 1902 amounted to 3,926 short tons, valued at $132,829, as compared with 4,444 short tons, valued at $158,100, in 1901, and with 3,185 short tons, valued at $123,475, in 1900. As reported to the Survey the prices varied from $20 to $60 a ton, the highest price being obtained for the North Carolina garnet. The average value per ton of the production in 1902 was $35.10, as compared with $35.57 per ton in 1901 and with $38.77 in 1900.

Grindstones.—The total value of all kinds of grindstones produced during 1902 was $667,431, as compared with $580,703 in 1901, an increase of $86,728. The production of 1900, valued at $710,026, still remains the largest on record for any year. It should be remembered, however, that the price per ton has decreased from $15 to from $8 to $10, and that therefore the tonnage of grindstones used has correspondingly increased within the last few years.

The imports for 1902 amounted in value to $76,906, as compared with $88,871 in 1901 and with $92,581 in 1900.

Infusorial earth and tripoli.—In 1902 the production of infusorial earth and tripoli amounted to 5,665 short tons, valued at $53,244, including $1,436 mined as by-product, an increase of 1,645 tons in quantity and an increase of $294 in value as compared with the production of 4,020 tons, valued at $52,950, in 1901.

Millstones and buhrstones.—The value of the production of millstones and buhrstones in 1902 was $59,808, an increase of $2,628 over that of 1901, which was $57,197. This was more than twice the value of the production of 1900, which amounted to $28,115. From 1886 to 1894 there was a very large decrease—from $140,000 to $13,887—in the production of buhrstones. Since 1894 there has been a gradual increase in the production.

Oilstones and whetstones.—There was a decided increase in the commercial domestic production of oilstones and whetstones during 1902, the value of which amounted to $221,762, as compared with $158,300 in 1901, an increase in 1902 of $63,462. Until 1902 the year of maximum production was 1899, when the value of the output amounted to $208,283. The crude product for 1902, as reported by the Census, was valued at $113,968.

CHEMICAL MATERIALS.

Arsenious oxide.—The domestic production of arsenious oxide (white arsenic) in 1902 was 1,353 short tons, valued at $81,180, as compared with 300 short tons, valued at $18,000, in 1901. The entire product was made by the Puget Sound Production Company at Everett, Wash., which began the manufacture of this important substance in 1901. The largely increased output in 1902 is a sign of the success of the new industry.

Borax.—The reported returns for 1902 gave an aggregate production of crude borax of 2,600 short tons, valued at $91,000, and of refined borax and boric acid of 17,404 short tons, valued at $2,447,619, of which it was stated that 862 short tons, valued at $155,000, were boric acid—a total of 20,004 short tons, valued at $2,538,619. The production during 1901 was 17,887 short tons of crude

borax and 5,344 short tons of refined borax, with a total value of $1,012,118.

Bromine.—The production of bromine in 1902, including the amount of bromine contained in potassium bromide, amounted to 513,890 pounds, valued at $128,472, as compared with 522,043 pounds, valued at $154,572, in 1901, a decrease for the year of 38,153 pounds in quantity and of $26,100 in value. The price per pound during 1902 averaged 25 cents, as compared with 28 cents in 1901, and with 29 cents in 1900. There has been practically no change in the bromine industry in the United States in 1902.

Fluorspar.—There was a large increase in the production of fluorspar in 1902 over that of 1901, due partly to its increased use for metallurgic purposes. The total commercial production in 1902 was 48,018 short tons, valued at $271,832, as compared with 19,586 tons, valued at $113,803, in 1901. This increase in production was not due to any one State, but there was a large increase in production in both Illinois and Kentucky, and also an increase in Arizona. The average price of crude fluorspar was reported as $5.19, as compared with $5 in 1901, and the average price of ground fluorspar was $9.98 per ton, as compared with $9.22 in 1901. The Census reports also 800 short tons, valued at $3,850, mined but not marketed in 1902.

Gypsum.—The production of gypsum, particularly for the manufacture of calcined plaster, continues to show a remarkable gain. The output of crude gypsum in 1902 was 816,478 short tons, valued in its first marketable condition at $2,089,341, as compared with 633,791 short tons, valued at $1,506,641, in 1901, and with 595,462 short tons, valued at $1,627,203, in 1900. The production in 1899 was 486,235 short tons, and in 1898 it was 291,638 short tons. The greatly increased production of the last four years is attributable to the largely increased use of plaster of Paris in large modern buildings and in the manufacture of staff for temporary buildings.

Marls.—The production of marls in the United States in 1902 was 12,439 short tons, valued at $12,741.

Phosphate rock.—The total commercial production of phosphate rock reported to the Survey in 1902 amounted to 1,490,314 long tons, valued at $4,693,444, as compared with 1,483,723 long tons, valued at $5,316,403, in 1901, an increase in quantity of 6,591 tons and a decrease in value of $622,959. The total quantity of phosphate rock reported by the Census as mined during 1902 was 1,548,720 long tons, valued at $4,922,943, as compared with 1,440,408 long tons in 1901.

Salt.—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda, and other sodium salts. The domestic production of salt in 1902 amounted to 23,849,221 barrels of 280 pounds net, valued at $5,668,636, as compared with 20,556,661 barrels, valued at $6,617,449, in 1901, and with 20,869,342 barrels, valued at $6,944,603, in 1900.

Sulphur and pyrite.—The domestic production of sulphur and of pyrite for the manufacture of sulphuric acid amounted to 207,874 long tons, valued at $947,089, as compared with a combined production of 241,691 long tons, valued at $1,257,879, in 1901. The production of sulphur was from Louisiana, Nevada, and Utah, named in the order of the importance of their outputs. Oregon and Idaho reported no production in 1902. The greater part of the output of pyrite was derived from Virginia, Georgia, North Carolina, Colorado, and Massachusetts, named in the order of production.

PIGMENTS.

Barytes.—The production of crude barytes in 1902 was considerably in excess of that of the year before, amounting to 58,269 short tons, valued at $193,884, as compared with 49,070 short tons, valued at $157,844, in 1901, an increase of 9,199 tons in quantity and of $36,040 in value. The average price per ton in 1902 was about $3.32, an increase of 10 cents over $3.22, the price in 1901, which was an increase of 44 cents over $2.78, the price in 1900.

Cobalt oxide.—The domestic production of cobalt oxide in 1902 was 3,730 pounds, valued at $6,714, as compared with 13,360 pounds, valued at $24,048, in 1901, a decrease in quantity of 9,630 pounds. All the cobalt oxide was obtained as a by-product in smelting lead ores at Mine Lamotte, Missouri.

Mineral paints.—The commercial production of mineral paints in 1902 amounted to 73,049 short tons, valued at $944,332, as compared with 61,460 short tons, valued at $789,962, in 1901. The Census reports the production of crude mineral paints in 1902 as 35,461 short tons, valued at $360,885, including 4,500 tons of ocher and metallic paint not marketed and valued at $18,000.

Zinc white.—The production of zinc white in 1902 amounted to 52,645 short tons, valued at $4,016,499, as compared with 46,500 short tons, valued at $3,720,000, in 1901.

MISCELLANEOUS.

Asbestos.—The asbestos commercially produced in the United States in 1902 was obtained chiefly from the mines at Sall Mountain, White County, Ga., but a small quantity was mined at Hinsdale, Berkshire County, Mass. The total commercial production was 1,005 short tons, valued at $16,200, an increase of 258 tons in quantity and of $2,702 in value over the production of 1901, which was 747 short tons, valued at $13,498. In addition the Census reports, as produced but not marketed, 1,500 short tons of crude asbestos, valued at $30,000. The production in 1900 was 1,054 short tons, valued at $16,310.

Asphaltum.—Under this title are included the various bitumens or hydrocarbons not discussed under the heading "Petroleum" in the volume on mineral resources. The commercial production in 1902 was 105,458 short tons, valued at $765,048, as compared with 63,134 short tons, valued at $555,335, in 1901—a large increase, amounting in quantity to 42,324 short tons and in value to $209,713. The production of crude material in 1902, as reported by the Census, was 66,238 short tons, valued at $236,728.

Bauxite.—In 1902 the production of bauxite increased to 29,222 long tons, valued at $128,206, as compared with

18,905 long tons, valued at $79,914, in 1901. Georgia yielded the greater bulk of the product, the remainder being supplied by Alabama and Arkansas.

Chromic iron ore.—California was the one State to produce any chromite during 1902, the quantity being 315 long tons, valued at $4,567, a decrease of 53 tons in quantity and of $1,223 in value as compared with the production of 1901, which was 368 long tons, valued at $5,790.

Feldspar.—The production of feldspar in 1902 was 45,100 short tons, valued at $282,639, as against 34,741 short tons, valued at $220,422, in 1901.

Fibrous talc.—This variety of talc or soapstone occurs in but one locality in the United States—Governeur, St. Lawrence County, N. Y. It is used principally as makeweight in the manufacture of paper. In 1902 the production was 71,100 short tons, valued at $615,350, an increase of $131,750 in value and of only 1,900 tons in quantity, as compared with the production of 69,200 short tons, valued at $483,600, in 1901.

Flint.—The production of flint in 1902 was 41,098 short tons, valued at $166,473, as compared with 34,420 short tons, valued at $149,297, in 1901.

Fuller's earth.—As reported to the Survey, the production of fuller's earth in 1902 showed a decrease from the production of 1901, being 9,842 short tons, valued at $84,418, as compared with 14,112 short tons, valued at $96,835, in 1901. The maximum production of fuller's earth was obtained in 1897 when the output was 17,113 short tons.

Graphite.—The commercial production of crystalline graphite during 1902 amounted to 3,936,824 pounds, valued at $126,144, as compared with 3,967,612 pounds, valued at $135,914, in 1901, and with 5,507,855 pounds, valued at $178,761, in 1900. The production of amorphous graphite in 1902 was 4,739 short tons, valued at $55,964, as compared with 809 short tons, valued at $31,800, in 1901. The decline in value was due to proportionate increase in production of the lower grades. The Census reports also 30,000 pounds of refined graphite, valued at $1,800, and 20,716 short tons of crude graphite, valued at

$43,600, as produced but not marketed in 1902. Considerable development and exploratory work was done during the year in Montana, Wyoming, North Carolina, and New Mexico. The production of artificial graphite was 2,358,828 pounds, valued at $110,700, the average price being 4.69 cents per pound, as compared with 2,500,000 pounds, valued at $119,000, in 1901, the average price being 4.75 cents per pound.

Limestone for iron flux.—The quantity of limestone used for fluxing in blast furnaces in 1902 was 10,150,078 long tons, valued at $5,138,539, as compared with 8,540,168 long tons, valued at $4,659,836, in 1901, and with 7,495,435 long tons, valued at $3,687,394, in 1900.

Lithium.—The production of lithium minerals in 1902 was 1,870 short tons, valued at $38,750 at the railroad, an increase of 120 tons in amount but a decrease of $4,450 in value as compared with the production of 1901, which was 1,750 tons, valued at $43,200. As far as can be ascertained the greater part of the lithium minerals mined during 1902 was not shipped. Although the price of these minerals was lower in 1902 than in 1901 for the same grade of mineral, there was apparently no increase in the home demand. There is, however, an increase in the demand for these minerals from foreign chemical manufacturers.

Magnesite.—The production of magnesite in the United States continues to be limited to California, and during the year 1902 the commercial production reported was 3,466 short tons, valued at $21,362—a large decrease as compared with the production in 1901, which was 13,172 short tons, valued at $43,057. Of the 1902 production, 380 tons, valued at $1,723, were sold but not mined in 1902.

Mica.—The production of plate mica in 1902 was 396,966 pounds, valued at $77,193. The production of scrap mica was 1,149 short tons, valued at $14,606; of unclassed mica, 234 tons, valued at $25,250.

Mineral waters.—The total production of mineral waters for 1902 was 64,859,451 gallons, valued at $8,793,761, as compared with 55,771,181 gallons, valued at $7,586,962,

in 1901—a gain in quantity of 9,088,263 gallons and in value of $1,206,799.

Molybdenum.—The commercial production of molybdenum in 1902 was approximately the same as that of 1901, but none of the product was shipped in 1902. The value of these molybdenum ores fluctuates very greatly, the highest price quoted being $1,500 per ton and the lowest $100.

Monazite.—The production of monazite is confined exclusively to North Carolina and South Carolina, by far the larger quantity being obtained from the former State, and in 1902 this amounted to 982,000 pounds, valued at $69,580, as compared with 748,736 pounds, valued at $59,262, in 1901—an increase in quantity of 233,264 pounds and in value of $10,318. The price per pound of the monazite produced in 1902 received by the miners varied from 2.5 to 5.5 cents, according to the percentage of thoria.

Precious stones.—The value of the gems and precious stones found in the United States in 1902 was $338,300, as compared with $289,050 in 1901, with $233,170 in 1900, and with $185,770 in 1899. There has been a great advance in the lapidary industry in the United States since 1894. The fact that larger establishments have been formed, which are able to purchase the rough diamonds in greater quantities, has placed our American diamond cutters in a position equal to that held by the cutters of Amsterdam, Antwerp, and Paris. The cutting of our native gems has also grown to the proportions of an industry, notably in the case of the beryls and the amethysts found in North Carolina and Connecticut; the turquoises from New Mexico, Arizona, Nevada, and California; the fine-colored and deep-blue sapphires found in Montana; the colored tourmalines of San Joaquin County, Cal.; the chrysoprases from Visalia, Tulare County, Cal.; the garnets of Arizona and New Mexico; and the pale-purple garnets of North Carolina.

Pumice stone.—The volcanic-ash deposits in Nebraska have been worked to some extent during 1902, the product being used in the manufacture of certain soaps and

scouring powders. The production of pumice amounted to 700 short tons, valued at $2,750.

Rutile.—The production of rutile in 1902 was less than in 1901.

Soapstone.—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of talc and soapstone in 1902 amounted to 26,854 short tons, valued at $525,157, as compared with 28,643 tons, valued at $424,888, in 1901—a decrease of 1,789 tons in quantity and an increase of $100,169 in value. The output for 1900 was 27,943 short tons, valued at $383,541, and for 1899 it was 24,765 short tons, valued at $330,805.

Tungsten.—The commercial production of crude tungsten ores during 1902 amounted to 183.5 short tons, having an estimated value of $28,442, of which not more than a few tons were sold. This does not represent the amount of tungsten ore sold in 1902, for 76 tons of concentrated ore mined in 1901 were sold in 1902. In 1901 the production amounted to 179 tons of concentrated ore, valued at $27,720. The larger part of the production of 1902 was from Colorado.

Uranium and vanadium.—There was a marked increase in the production of uranium and vanadium minerals in 1902, which, as reported to the Survey, amounted to 3,810 short tons, valued at $48,125, or $12.63 per ton. This, of course, represents the crude ore. A portion of uranium ore was treated in 1902, giving a concentrated product of 25 tons, valued at $8,000, or $320 per ton.

Glass sand.—The production of glass sand in 1902, including the production of 848,004 short tons of engine, furnace, building, molding, and other sands, mined incidentally and valued at $561,889, was 857,165 short tons, valued at $721,270—a total production of 1,705,169 short tons of sand, valued at $1,283,159.

Division of Physical and Chemical Research.

During the last fiscal year the scientific force of this division remained unchanged.

In the chemical laboratory 225 analyses were finished, mostly of rocks and coals. There were made also 443

qualitative determinations of minerals, etc., received from various sources. This work represents the routine of the laboratory.

Clarke and Steiger's research into the action of ammonium choride on silicates was finished, and the results were published in the autumn as Bulletin No. 207. Mr. Steiger is continuing the research, or rather a variant of it, and is replacing the alkalies of certain silicates by silver, lead, and other bases. So far as this work has gone the results are promising. Mr. Clarke, at the request of Professor Van Hise, discussed the composition of glauconite and of the peculiar mineral which Mr. C. K. Leith calls "greenalite," and proved them to be distinct. The discussion forms a passage in Mr. Leith's monograph (Monograph XLIII). Mr. Clarke also described a peculiar "serpentine" from the State of Washington, which proves to be a mixture of brucite, chlorite, hydromagnesite, and serpentine, containing about 60 per cent brucite.

Mr. Hillebrand continued from time to time his experiments upon methods for the analysis of cements. This work was undertaken at the request of the New York section of the Society for Chemical Industry, and has determined the more serious sources of error in this class of commercial analyses. Mr. Allen published an important paper on organic bases as precipitants and discovered an accurate method for separating small quantities of aluminum, titanium, etc., from iron. Mr. Stokes continued his extensive researches into the secondary deposition of ores, but the unpublished data are not yet complete enough to warrant any discussion here.

Apart from the purely geologico-chemical work of the division, Mr. Clarke published an elaborate memoir entitled "A New Law in Thermochemistry," in which he has shown that the absolute heat of formation of organic compounds is a function, generally quite simple, of the number of atomic unions within the molecule. The heat of formation of a number of elementary molecules is computed, and nearly all the values appear to be multi-

ples of one fundamental constant, approximately 13,773 calories.

During May and June Mr. Clarke was absent in Europe, attending the International Congress of Applied Chemistry at Berlin and visiting laboratories and mineral collections.

The experimental work of the physical laboratory was mainly upon the behavior of the rock-forming minerals and analogous but somewhat simpler chemical compounds at high temperatures.

A serious technical difficulty was encountered early in the year in obtaining sufficiently high temperatures for this work by electrical resistance methods. The usual insulating materials used in resistance furnaces begin to lose their insulating quality at 1,000° C. or soon after, and can not be used for higher temperatures. After many unsuccessful trials a mixture was found which served the purpose very well, and the furnace is now in constant use for all temperatures up to 1,600° C. The method enables both the temperature and the conductivity of the material under investigation to be simultaneously measured in an oxidizing or reducing atmosphere without disturbing combustion gases, and leaves little to be desired as a furnace for mineral investigation.

As soon as the furnace had been brought into good working order, the melting temperatures of the principal rock-forming minerals were taken up, beginning with representative feldspars. The method of measurement was a most sensitive one, chosen and perfected with a view to identifying and locating any physical change which might occur in heating a mineral without leaving any important fact to the personal judgment of the observer. For example, the melting point was determined, not as the point where the powdered mineral was seen to shrink together into a more or less viscous mass—a slow process upon which two observers rarely agree—but the point where the absorption of heat indicated that a change of state was taking place. This

method has given results of permanent value, a number of which were quite new, and promises to throw much light on the hitherto little understood conditions which produce sintering and the mineral glasses, or, speaking more generally, to bring the minerals into their proper place in modern physical chemistry. A paper "On the Melting Point of a Simple Glass," containing some of the results thus far attained, was presented by Mr. Arthur L. Day at the spring meeting of the National Academy of Sciences. The work is still in progress, and plans are completed and necessary equipment is ordered which will virtually double the plant during the coming year and occupy two observers continuously.

Experiments upon the linear force exerted by growing crystals were continued as opportunity offered. It is a study of very slow and rather inaccessible processes, and the data are still incomplete.

Mr. Day was engaged in these researches during the entire year, Mr. Allen during the spring months, as the routine work of the chemical laboratory permitted.

Mr. Van Orstrand assisted Mr. Becker with the mathematical work on the elastic relations in finite strains and kindred subjects during the entire year.

Mr. Becker's time was mainly occupied in discussing problems of geologic mechanics and in planning work for the division. Some weeks, however, were occupied in acting as secretary of a committee of the National Academy of Sciences, appointed to report upon plans for coordination of scientific surveys of the various kinds carried out under the Government in the work of exploration.

TOPOGRAPHIC BRANCH.

Organization and Summary.

The organization of the topographic branch remained the same as in previous years until May 1, 1903, the date on which the new manual of "Instructions" took effect, when the branch was organized for administrative pur-

poses in two divisions, and one of these divisions in five sections, viz:

Division of topography:
- Atlantic section, Mr. H. M. Wilson, geographer in charge.
- Central section, Mr. John H. Renshawe, geographer in charge.
- Rocky Mountain section, Mr. E. M. Douglas, geographer in charge.
- Pacific section, Mr. Richard U. Goode, geographer in charge until his death, June 9, 1903. (Mr. Goode also served as chairman of the topographic committee, composed of the above-mentioned geographers.)
- Triangulation and computing section, Mr. S. S. Gannett, geographer in charge.

Division of geography and forestry, Mr. Henry Gannett, geographer in charge.

Changes in the topographic corps were the death of Mr. Goode on June 9[a], the appointment of Carl L. Sadler, Joseph F. McBeth, and Richard T. Evans, assistant topographers; E. I. Ireland, W. O. Tufts, R. W. Berry, Gilbert Young, Herbert H. Hodgeson, M. J. Munn, Clarence L. Nelson, Hoyt L. Johnston, J. R. Eakin, and J. I. Gayetty, topographic aids, and Vladimir Sournin, topographic draftsman; the resignation of Paul Holman and Albert H. Bumstead, topographers; the transfer to the hydrographic branch of E. T. Perkins, J. E. Rockhold, and W. T. Turner, topographers, and the transfer to the Navy Department of Walter R. Harper, assistant topographer. Mr. D. L. Reaburn was detailed during November and the first part of December to make for the Navy Department certain surveys of sites for a proposed naval training station. Mr. W. J. Peters, topographer, was granted leave of absence from June 1, 1903, for the purpose of accompanying the Zeigler north-pole expedition as second in command and chief of scientific staff.

Cooperative arrangements were made with twelve States, $22,000 being allotted by the State engineer and surveyor of New York, $15,000 by the State survey commission of Pennsylvania, $15,000 by the State geologist of West Virginia, $20,000 by the governor of Ohio, $2,500 by the State

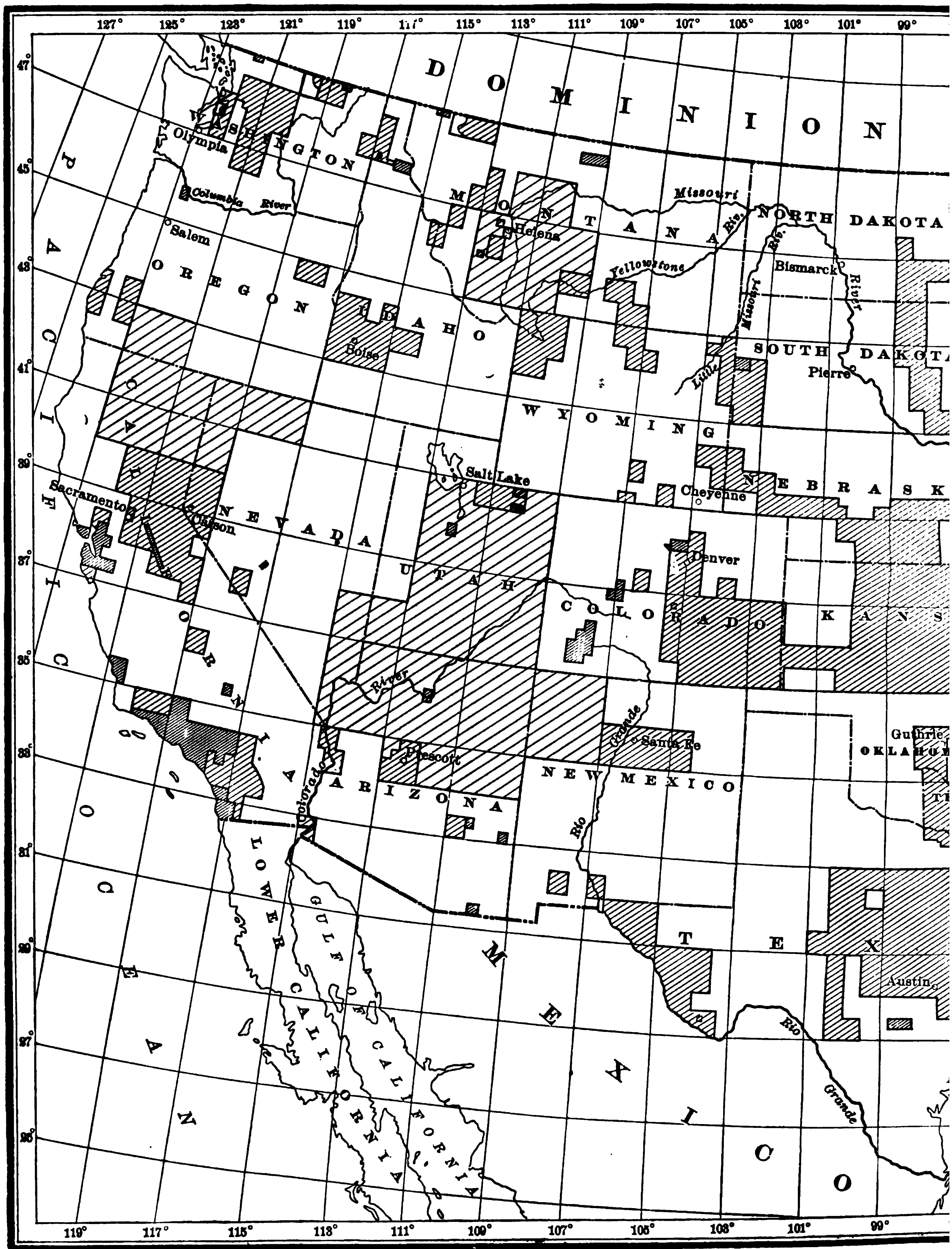
[a] See biographic notice on pages 287-290.

survey commission of Maine, $6,000 by the State geologist of Maryland, $5,000 by the State geologist of North Carolina, $1,000 by the State geologist of Alabama, $2,000 by the State geologist of Michigan, $1,400 by the Mississippi Experiment Station of Mississippi, $1,000 by the Louisiana Experiment Station of Louisiana. Thus $90,000 was added by the States mentioned to the Federal appropriation for topographic work.

In connection with the topographic surveys, the surveys of forest reserves, reclamation surveys, Alaskan surveys, and the survey of the Northwest boundary the following results were obtained:

Two base lines were measured; primary azimuth observations were made at 4 triangulation stations; 395 triangulation stations were occupied or located; 1,487 miles of primary traverse were run; 36,275 square miles were covered by detailed topographic mapping, this area being distributed through 36 States and Territories; 29,160 miles of levels were run, and 1,826 permanent bench marks were established, these bench marks being iron posts, bronze or aluminum tablets, or copper or aluminum plugs. In connection with the Alaskan surveys, about 20,080 square miles were mapped topographically. With reference to boundary surveys, 45 miles of the boundary of the Bighorn Forest Reserve of Wyoming were surveyed and marked with special iron posts, thus completing the reserve; also 154 miles of the boundaries of the Black Mesa Forest Reserve and 12 miles of those of the Mount Graham Forest Reserve of Arizona were surveyed and marked with special iron posts.

The condition of topographic work to April 30, 1902, distinguished as to scale, is shown on the general map of the United States, Pl. II, and the detailed distribution of this work in the various States and Territories, including Alaska, is shown on the 23 accompanying maps (Pls. I and III–XXIV). On the latter are indicated the published sheets to June 30, 1902, the sheets in course of publication, and the areas surveyed in 1901–2 to April 30.



MAP OF THE UNITED STATES, SHOWING A

AND THE SCALE EMPL

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AREAS COVERED BY TOPOGRAPHIC SURVEYS

PLOTTED FOR EACH AREA.

Scale

100 200 300 miles

903

The following tables give the details relating to topography and spirit leveling for the fiscal year:

Topographic surveys of the United States Geological Survey in 1902-3, to April 30, including levels run and permanent bench marks established.

State or Territory.	Contour interval.	Scale of publication.		Total area surveyed.	Levels.	
		1:62,500.	1:125,000.		Distance run.	Number of bench marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Alabama	50	....	892	892	398	16
Arizona	10-50-100	171	2,295	[a] 3,009	1,202	300
Arkansas	50	....	1,121	1,121	458	24
California	10-25-50-100	118	3,397	[a] 3,762	1,700	304
Colorado	20-50-100	607	....	[b] 633	168	55
Illinois	10-20	438	....	438	646	15
Indian Territory	50	....	60	60	....	....
Indiana	20	23	....	23	43	1
Iowa	20	....	118	118	129	....
Kansas	20	....	944	944	568	24
Kentucky	20-50	250	317	567	941	7
Louisiana	20	....	110	110	369	8
Maine	20	330	....	330	107	6
Maryland	20	1,463	....	1,463	1,109	23
Michigan	20	....	775	775	1,116	21
Minnesota	20	....	195	195	131	6
Missouri	20	468	....	468	439	16
Montana	20-100	791	1,189	1,980	358	92
Nebraska	20	....	905	905	721	17
Nevada	50	....	....	[c] 7	....	....
New Mexico	....	....	....	....	412	132
New York	20	3,099	....	3,099	2,679	112
North Carolina	10-20-100	2,167	82	2,249	5,007	82
North Dakota	20	....	632	632	426	15
Ohio	10-20	2,144	....	2,144	4,390	92
Oregon	100	....	278	278	368	123
Pennsylvania	20	1,713	....	1,713	1,787	62
South Carolina	20	....	748	748	447	....
Tennessee	50-100	....	610	610	391	19
Texas	10-25-50-100	353	1,233	[d] 1,651	367	98
Utah	100	....	390	390	123	32

[a] 247 square miles in California and 543 square miles in Arizona on scale of 1:63,360.
[b] 26 square miles on scale of 1:25,000.
[c] 7 square miles on scale of 1:96,000.
[d] 65 square miles on scale of 1:50,000.

Topographic surveys of United States Geological Survey, etc.—Cont'd.

State or Territory.	Contour interval.	Scale of publication. 1:62,500.	1:125,000.	Total area surveyed.	Levels. Distance run.	Number of bench marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Vermont	20	216	....	216	136	6
Washington	50-100	....	2,497	2,497	275	17
West Virginia	20	1,553	....	1,553	1,379	34
Wisconsin	20	....	82	82	108	19
Wyoming	50	....	475	475	304	90
Total	....	15,904	19,345	36,137	29,202	1,868

Present condition of topographic surveys and the new areas surveyed in 1902-3.

[Areas which were resurveyed are not included in this table.]

State or Territory.	Total area.	Area surveyed in 1902-3.	Total area surveyed to Apr. 30, 1903.	
	Square miles.	*Square miles.*	*Square miles.*	*Per cent.*
Alabama	52,250	892	18,225	35
Arizona	113,020	3,009	62,376	56
Arkansas	53,850	1,121	20,003	37
California	158,360	3,762	65,578	41
Colorado	103,925	607	34,974	34
Connecticut	4,990	....	4,990	100
Delaware	2,050	....	818	40
District of Columbia	70	....	70	100
Florida	58,680	....	1,821	3
Georgia	59,475	....	14,522	24
Idaho	84,800	....	14,369	17
Illinois	56,650	438	4,963	9
Indian Territory	31,400	....	30,885	99
Indiana	36,350	23	2,146	6
Iowa	56,025	118	9,323	17
Kansas	82,080	....	62,806	77
Kentucky	40,400	567	12,094	30
Louisiana	48,720	110	7,602	16
Maine	33,040	330	5,762	17
Maryland	12,210	1,463	11,770	96
Massachusetts	8,315	....	8,315	100
Michigan	58,915	775	2,849	5
Minnesota	83,365	195	3,707	4

Present condition of topographic surveys, etc.—Continued.

State or Territory.	Total area.	Area surveyed in 1902-3.	Total area surveyed to Apr. 30, 1903.	
	Square miles.	*Square miles.*	*Square miles.*	*Per cent.*
Mississippi	46,810	....	227	....
Missouri	69,415	....	32,926	47
Montana	146,080	1,980	42,258	29
Nebraska	77,510	905	27,133	35
Nevada	110,700	7	28,956	26
New Hampshire	9,305	....	2,396	26
New Jersey	7,815	....	7,815	100
New Mexico	122,580	....	27,777	23
New York	49,170	3,099	31,256	64
North Carolina	52,250	2,167	15,886	30
North Dakota	70,795	632	6,959	10
Ohio	41,060	2,144	7,723	20
Oklahoma	39,030	....	4,146	11
Oregon	96,030	278	15,691	16
Pennsylvania	45,215	1,713	14,256	31
Rhode Island	1,250	....	1,250	100
South Carolina	30,570	748	4,886	16
South Dakota	77,650	....	17,222	22
Tennessee	42,050	92	19,443	46
Texas	265,780	1,651	61,983	23
Utah	84,970	390	64,670	76
Vermont	9,565	216	3,060	32
Virginia	42,450	....	29,227	69
Washington	69,180	2,497	13,417	19
West Virginia	24,780	1,553	19,859	80
Wisconsin	56,040	82	10,395	18
Wyoming	97,890	475	18,927	19
Total	3,024,880	34,039	929,712	31

Division of Topography.

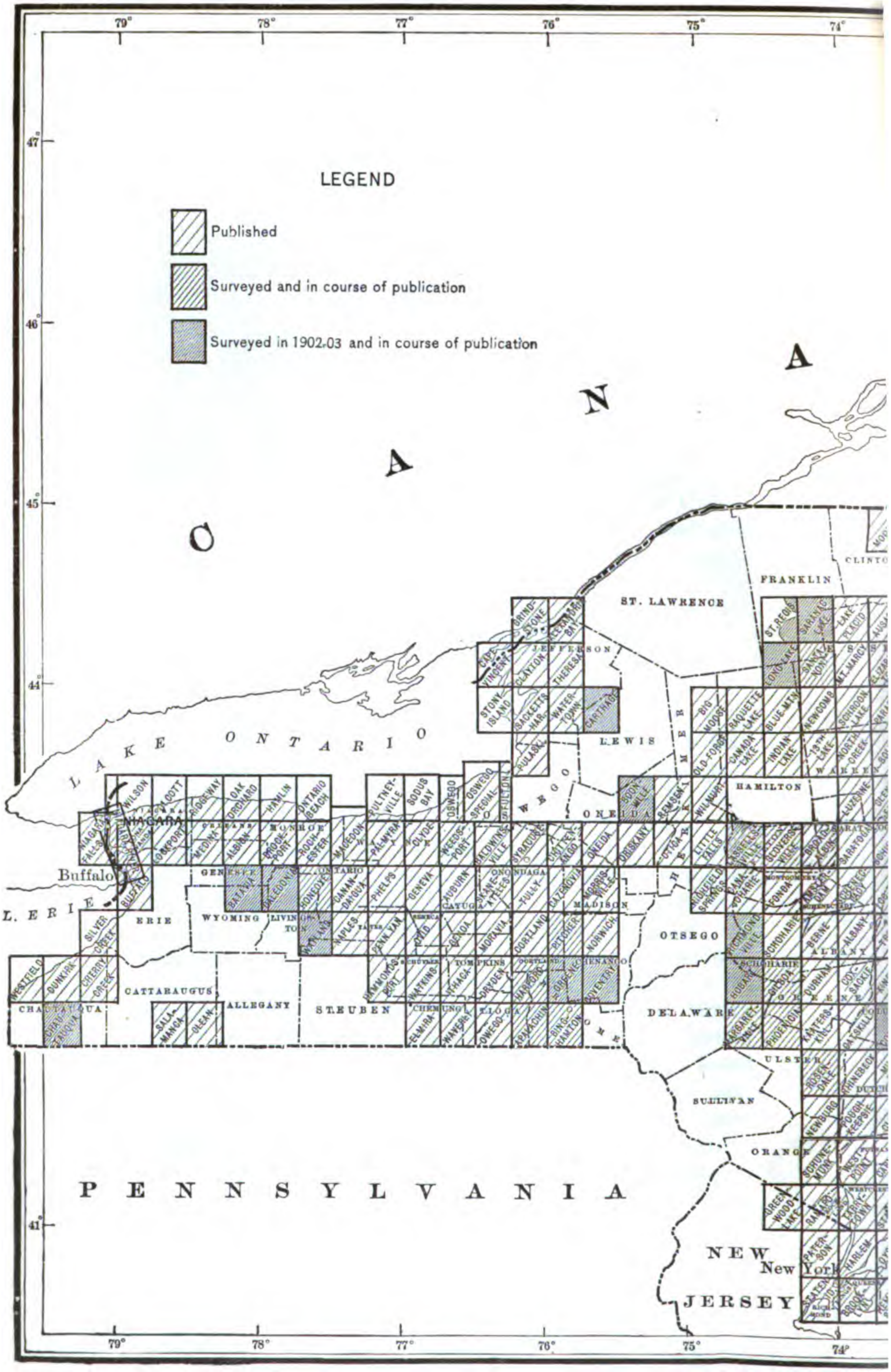
ATLANTIC SECTION.

Topographic work was carried on during the season by parties working in twelve States, namely, New York, Pennsylvania, West Virginia, Ohio, Maryland, Vermont, Maine, Tennessee, North Carolina, South Carolina, Delaware, and Kentucky. The survey of 52 quadrangles was completed, and 28 were partially surveyed. The total

new area mapped was 11,864 square miles, of which 10,707 were for publication on the scale of 1:62,500 and 1,157 were for publication on the scale of 1:125,000. In addition, 600 square miles on the scale of 1:125,000 were resurveyed. In connection with this work 13,713 linear miles of levels were run and 351 permanent bench marks were established.

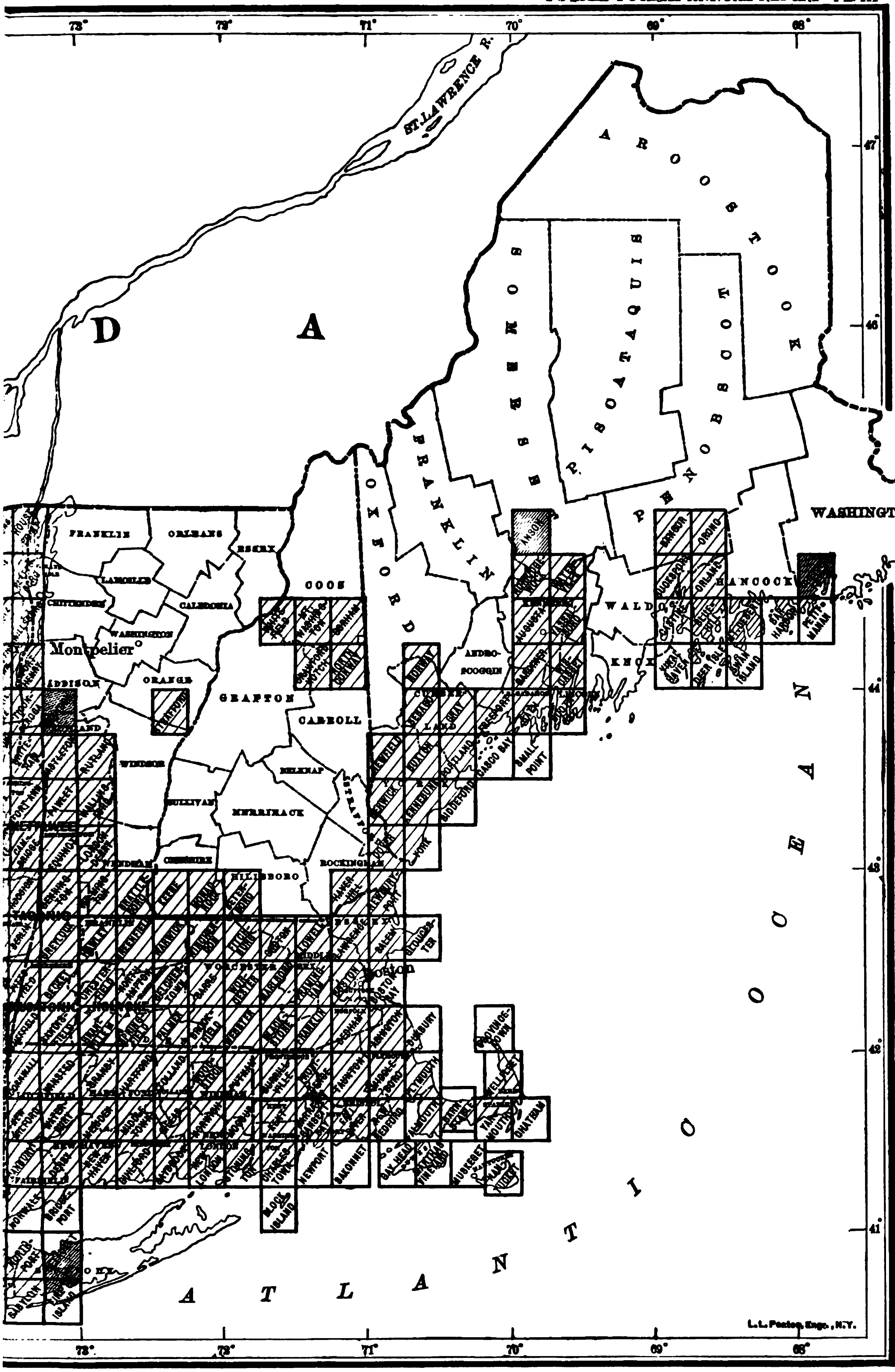
New York.—In chapter 594 of the laws of 1902 authority was granted the State engineer and surveyor of New York to continue cooperation with this Bureau in making a topographic survey and map of New York. An agreement was entered into between the State engineer and surveyor of New York and the Director of the United States Geological Survey by which it was provided that the cooperative survey of the State should be continued in accordance with the agreement signed by them in 1899. Under the terms of this agreement the State allotted $20,000, to which $2,000 of the unallotted balance of the State appropriation of 1901 was added. The Federal Bureau also allotted $22,000 for the same work.

Nine parties were maintained on topographic work in New York during the season, which commenced in May and lasted through November, and a few additional parties worked for short periods of time. Mr. J. H. Jennings, topographer, with Messrs. Gilbert Young, J. M. Whitman, jr., and E. G. Hamilton, assistant topographers, had charge of parties which completed the mapping of Carthage, Greene, Booneville, Coventry, and Hobart quadrangles and controlled and partially mapped the Highmarket, Orwell, Taberg, and Piseco Lake quadrangles. Mr. Glenn S. Smith, topographer, with Messrs. T. Foster Slaughter, George H. Guerdrum, and J. M. Whitman, jr., assistant topographers, had charge of parties which completed the mapping of Saranac Lake, Long Lake, Setauket, and Fire Island quadrangles, and also controlled and partially mapped the St. Regis, Tupper Lake, and Loon Lake quadrangles. Messrs. A. C. Roberts, C. C. Bassett, W. H. Lovell, and A. H. Bumstead,



MAP OF MAINE, NEW HAMPSHIRE, VERMONT, MASSAC

SHOWING PROGRESS OF



USETTS, RHODE ISLAND, CONNECTICUT, AND NEW YORK,
'OPOGRAPHIC SURVEYING.

topographers, and Mr. E. G. Hamilton, assistant topographer, had charge of parties which completed the mapping of Wayland, Caledonia, Chautauqua, Richmondville, Batavia, and Copake quadrangles and partially mapped the Clymer, Falconer, and Mount Morris quadrangles, also securing control for the Nineveh quadrangle. These quadrangles cover portions of Allegany, Broome, Cattaraugus, Chautauqua, Chenango, Cortland, Clymer, Delaware, Dutchess, Essex, Franklin, Genesee, Greene, Hamilton, Herkimer, Jefferson, Lewis, Livingston, Oneida, Oswego, Otsego, Schoharie, St. Lawrence, Steuben, Suffolk, and Wyoming counties. The total area surveyed was 3,099 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 2,566 linear miles of levels were run and 103 permanent bench marks were established.

A party under Mr. David H. Baldwin was employed during July and August in running three short check lines to cut up the larger precise-level net, in which some slight discrepancies had been discovered. This party extended work in the neighborhood of Scottville, Monroe County, whence the line was brought in the previous season from the United States engineers bench mark at Charlotte, north of Rochester, and run southward via Mount Morris to Hornellsville, where connection was made with the precise-level line previously run by the United States Geological Survey. Mr. Baldwin also extended levels from the United States engineers bench mark at Buffalo along the shore, where connection was made with another precise bench mark of this Survey. He then extended a tie line from Salamanca southwestward to the Pennsylvania boundary line, to check an error in previous leveling. There were in all 113 miles of precise levels run, in connection with which 9 permanent bench marks were established.

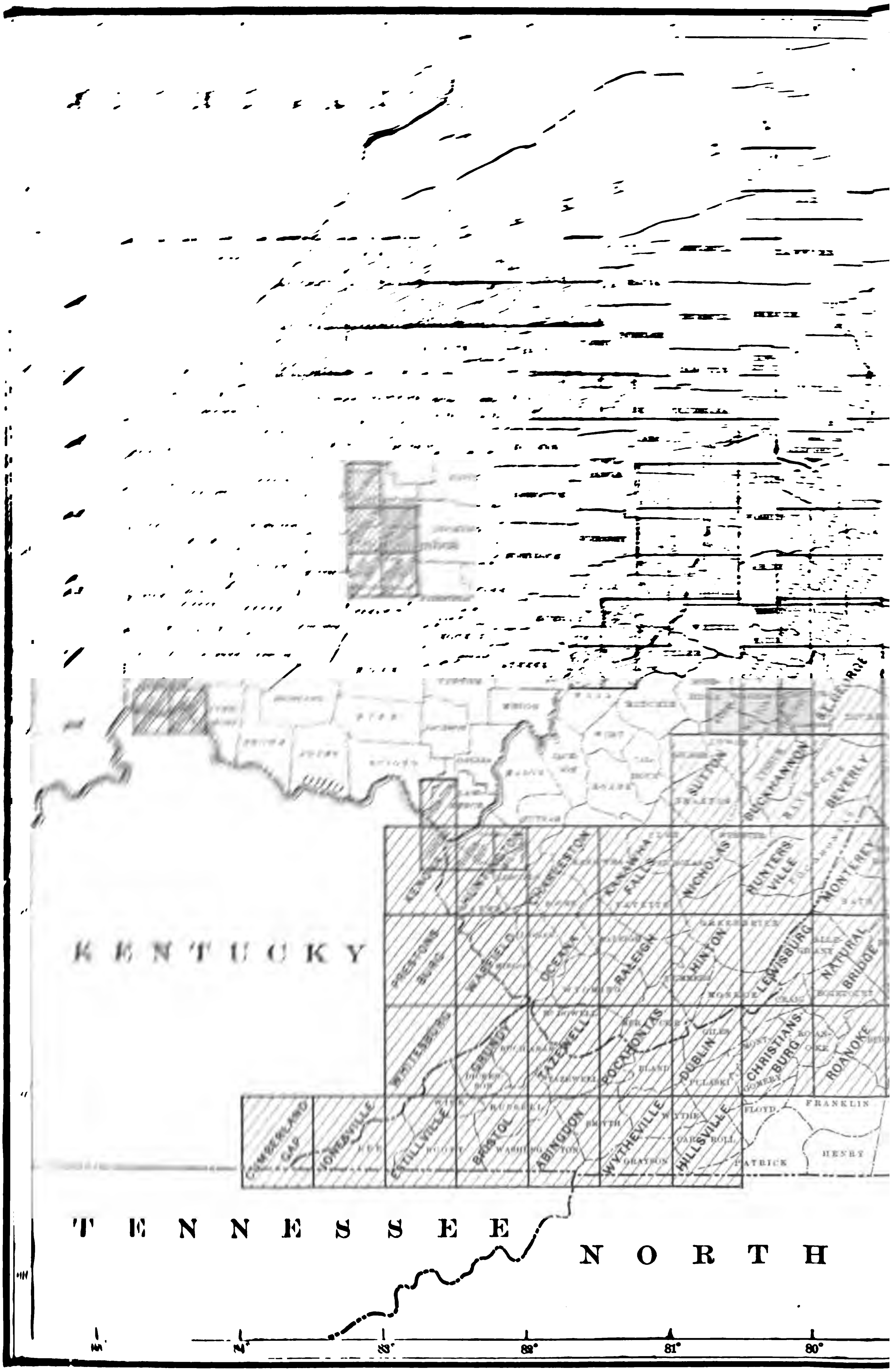
Pennsylvania.—An arrangement was agreed upon by which the sum of $15,000 was allotted by the State survey commission of Pennsylvania for the making of a

cooperative topographic survey to be met by a like amount by the United States Geological Survey, thus making available $30,000.

Five parties were maintained on field work in Pennsylvania during the season, which extended from the middle of May until the middle of October. Messrs. Frank Sutton and Robert D. Cummin, topographers, with Messrs. E. I. Ireland and T. G. Basinger, assistant topographers, had charge of a group of parties which completed the mapping of the Barnesboro, Curwensville, Ebensburg, and Patton quadrangles, partially mapped the Houtzdale quadrangle, and secured partial control for the Johnstown, Punxsutawney, Rogersville, and Sideling Hill quadrangles. Mr. Cummin had charge of a party which completed the survey of the Amity quadrangle, and Messrs. E. B. Clark and J. H. Wheat, topographers, had charge of parties which completed the Eldersridge, Lancaster, and Newcastle quadrangles. These surveys cover portions of Washington, Indiana, Cambria, Clearfield, Bedford, Blair, Armstrong, Westmoreland, Lancaster, Lebanon, Lawrence, Beaver, Center, Jefferson, Greene, Fulton, and Franklin counties. The total area surveyed was 1,694 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet, in connection with which 1,693 linear miles of levels were run and 56 permanent bench marks were established.

In northern Pennsylvania 63 miles of precise levels were run by Mr. Baldwin in order to check the precise-level net of Pennsylvania and thus furnish data by which all the levels could be reduced to mean sea level. In the course of this work four permanent bench marks were established.

West Virginia-Ohio.—Work was prosecuted in West Virginia under the agreement entered into by the Director of the United States Geological Survey and the State geologist of West Virginia in 1901 by which the State geological survey allotted $15,000 for cooperative work in 1902, to be met by a like sum from the United States Geological Survey.



MAP OF PENNSYLVANIA, NEW JERSEY, DELAWARE,
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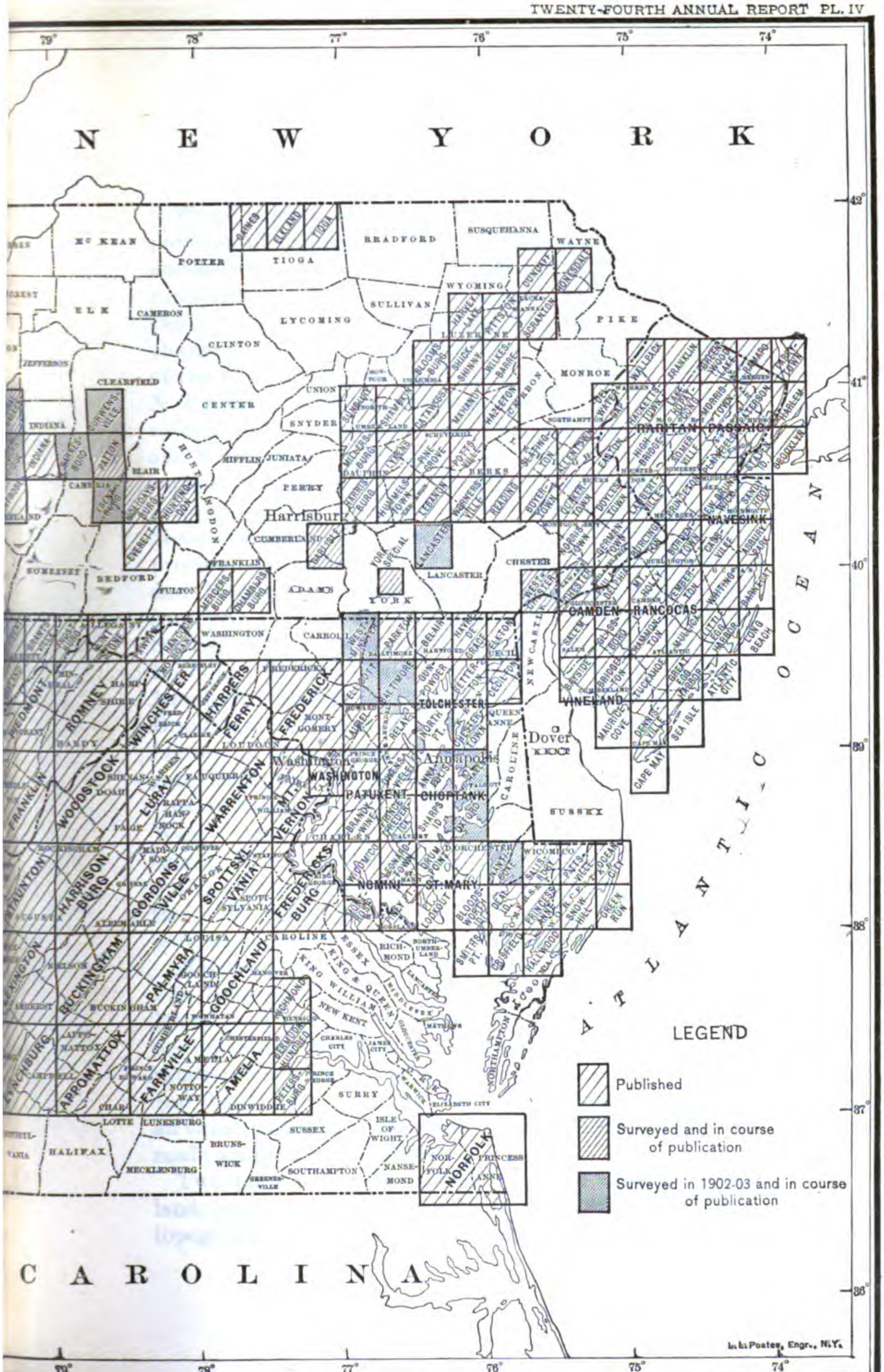


MARYLAND, VIRGINIA, WEST VIRGINIA, AND OHIO,
OPOGRAPHIC SURVEYING.

Three parties were maintained on field work during portions of the season, which commenced early in May and lasted through November. Mr. A. M. Walker, topographer, assisted at times by Messrs. E. S. Ela, R. W. Berry, and E. I. Ireland, assistant topographers, was in charge of a group of parties which completed the mapping of the Philippi, Weston, and Vadis quadrangles. Mr. W. N. Brown, topographer, was in charge of a party which completed the mapping of the Cameron, Bruceton Mills, and Blacksville quadrangles. Mr. W. N. Morrill, topographer, was in charge of a party which completed the mapping of the Parkersburg and Waverly quadrangles. Messrs. Walker and Brown had charge of parties which procured secondary control for portions of the Burnsville and Mannington quadrangles. The cost of the areas surveyed in Ohio and Pennsylvania was borne by those States. The above surveys covered portions of Harrison, Barbour, Upshur, Taylor, Lewis, Doddridge, Gilmer, Marshall, Monongalia, Preston, Wood, Ritchie, Pleasant, Braxton, and Marion counties, W. Va.; Fayette, Washington, and Greene counties, Pa., and Washington, Morgan, Belmont, and Monroe counties, Ohio. The total area surveyed by the Atlantic section of topography in West Virginia was 1,428 square miles, and in Ohio 310 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In connection with this work 1,488 linear miles of levels were run and 36 permanent bench marks were established.

Maryland.—Under a cooperative arrangement entered into between the State geologist of Maryland and the Director of the United States Geological Survey it was provided that $6,000 should be allotted from the appropriation made for the work of the State geological survey and that the United States Geological Survey should allot an equal amount for the same work. The total sum thus made available was $12,000.

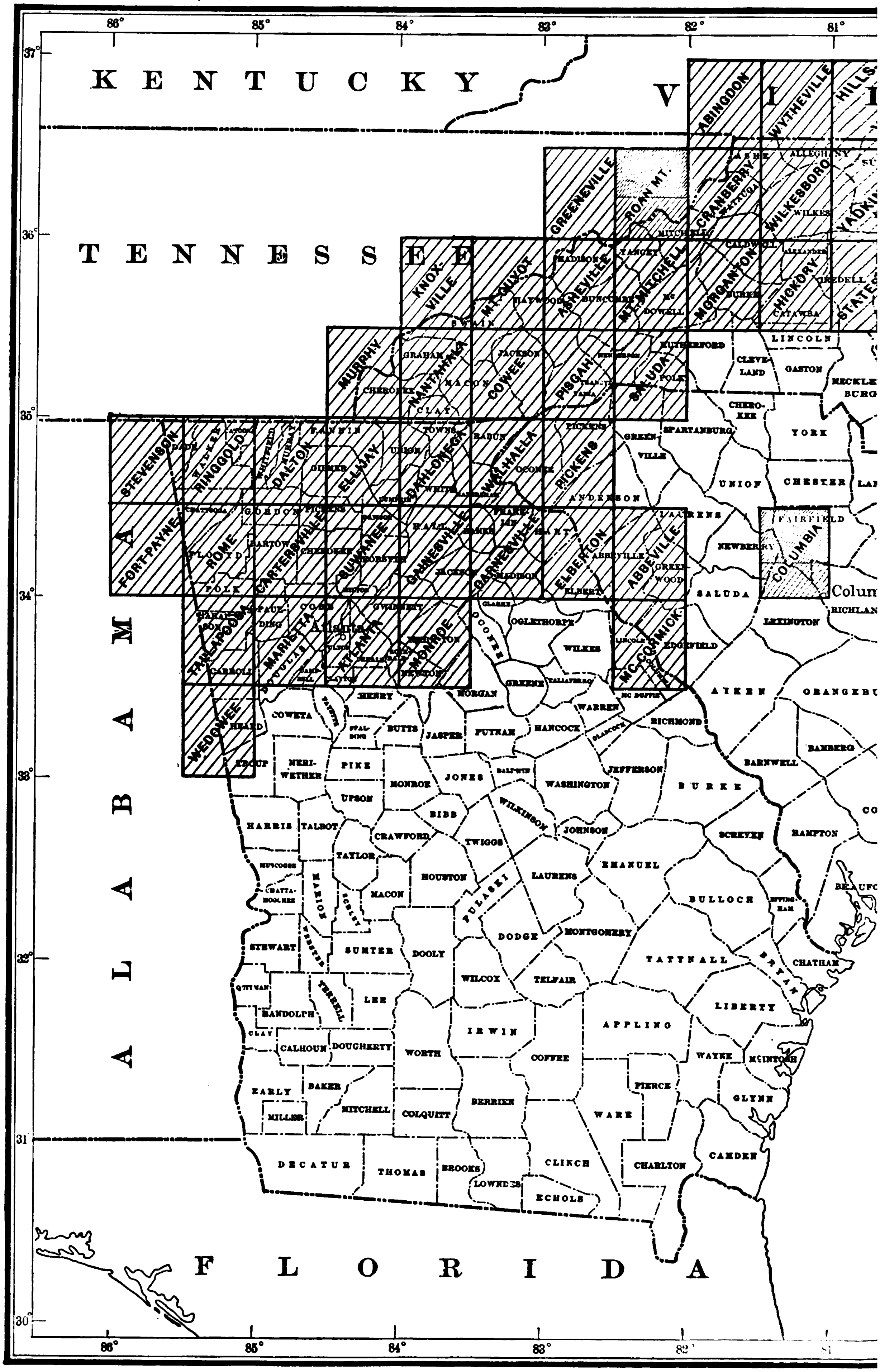
Two parties were maintained on field work in Maryland, commencing early in April. Mr. W. Carvel Hall, topographer in charge, and Messrs. Ela and Basinger had

charge of parties which completed the mapping of the Annapolis, Baltimore, North Point, Oxford, Sharps Island, St. Michaels, and Nanticoke quadrangles, and partially mapped the Denton, Ellicott, Preston, and Relay quadrangles, the Seaford quadrangle of Maryland-Delaware, and the Westminster quadrangle of Maryland-Pennsylvania. These surveys cover portions of Anne Arundel, Kent, Carolina, Dorchester, Somerset, Wicomico, Talbot, Queen Anne, Baltimore, Howard, and Prince George counties, Md.; Sussex County, Del.; and York and Adams counties, Pa. The total area surveyed was 1,463 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 1,109 linear miles of levels were run and 23 permanent bench marks were established.

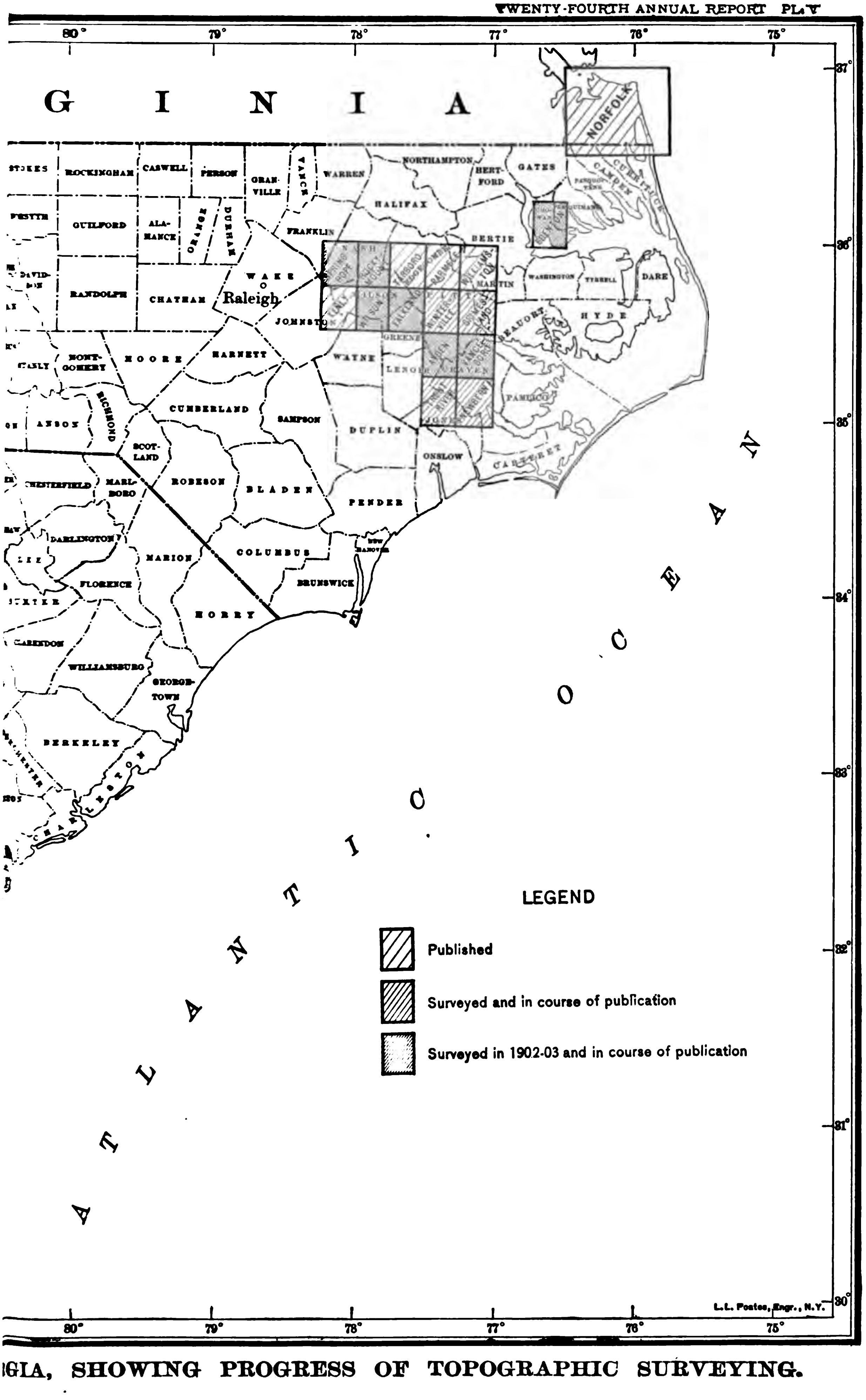
Maine.—An appropriation of $2,500 was made by the State legislature of Maine for the year 1902, and an equal sum was allotted by the United States Geological Survey. The surveys were to be governed by the terms of the agreement entered into between the commissioners of the State of Maine and the Director in 1899.

One field party, under Mr. W. H. Lovell, topographer, was engaged in field work during May, June, July, and August, which resulted in the mapping of 330 square miles, included in the Anson and Cherryfield quadrangles, in Somerset and Washington counties. This work was for publication on the scale of 1:62,500, with a contour interval of 20 feet, and in connection with it 107 miles of levels were run and 6 permanent bench marks were established.

North Carolina.—Under an agreement made between the commissioner of agriculture of North Carolina and the Director of the United States Geological Survey, it was provided that the total cost to the State in topographic mapping should not exceed $20,000 for the years 1901 and 1902, and that the United States Geological Survey should expend an equal amount upon the same work. For the convenience of both parties and because of the condition of their various appropriations, it was arranged that North



MAP OF NORTH CAROLINA, SOUTH CAROLINA, AND GEO



IGIA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Carolina should expend for the year ending June 30, 1903, $6,111.82, and the United States Geological Survey $15,000, making a total of funds available of $21,111.82.

A group of parties under the general supervision of Mr. Albert Pike, topographer, was maintained throughout the season, from early March to late December. Mr. Robert Coe, assistant topographer, remained with Mr. Pike as principal assistant, and Messrs. A. H. Bumstead and T. F. Slaughter reported in the fall to complete the sketching. Mr. W. L. Miller, topographer, assisted in the early part of the year by Mr. Coe, was engaged from March to June in mapping the uncompleted portions of the Vanceboro and Ayden quadrangles. This group of parties completed the survey of the Tarboro, Rocky Mount, Vanceboro, Ayden, Wilson, Falkland, Kenly, Spring Hope, and Edenton quadrangles for publication on the scale of 1:62,500, with a contour interval of 10 and 20 feet. The area surveyed was 2,159 square miles in portions of Edgecombe, Pitt, Wilson, Beaufort, Craven, Lenoir, Greene, Wayne, Johnston, Nash, Bertie, Perquimans, Chowan, and Hertford counties. In addition, some secondary control and a little topographic mapping, amounting to about 8 square miles, was completed in the Eagle Rock, Raleigh, Hertford, and Selma quadrangles, in portions of Wake, Franklin, and Pasquotank counties. In connection with the above work 5,007 miles of levels were run and 82 permanent bench marks were established.

Vermont.—Mr. C. C. Bassett, topographer, was in charge of a party engaged from July to October in the survey of the Brandon quadrangle, in Rutland and Addison counties. The total area mapped was 216 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 136 miles of levels were run and 6 permanent bench marks were established.

Tennessee-North Carolina.—Mr. Hersey Munroe, topographer, during July, and Mr. George H. Guerdrum, topographer, from August to November, were in charge of a party engaged in the resurvey of the Roan Mountain quadrangle, in Mitchell and Yancey counties, N. C., and

Sullivan, Carter, Washington, and Unicoi counties, Tenn. The total area surveyed was 600 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, thus completing the Roan Mountain quadrangle. In the course of this work 170 miles of levels were run and 7 permanent bench marks were established.

Tennessee.—Mr. E. G. Hamilton, assistant topographer, was in charge of a party from September to November engaged in preparing secondary control for the mapping of the Mannie quadrangle, in portions of Wayne, Lawrence, and Lewis counties, and also surveyed 92 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet, in connection with which 221 miles of levels were run and 12 permanent bench marks were established.

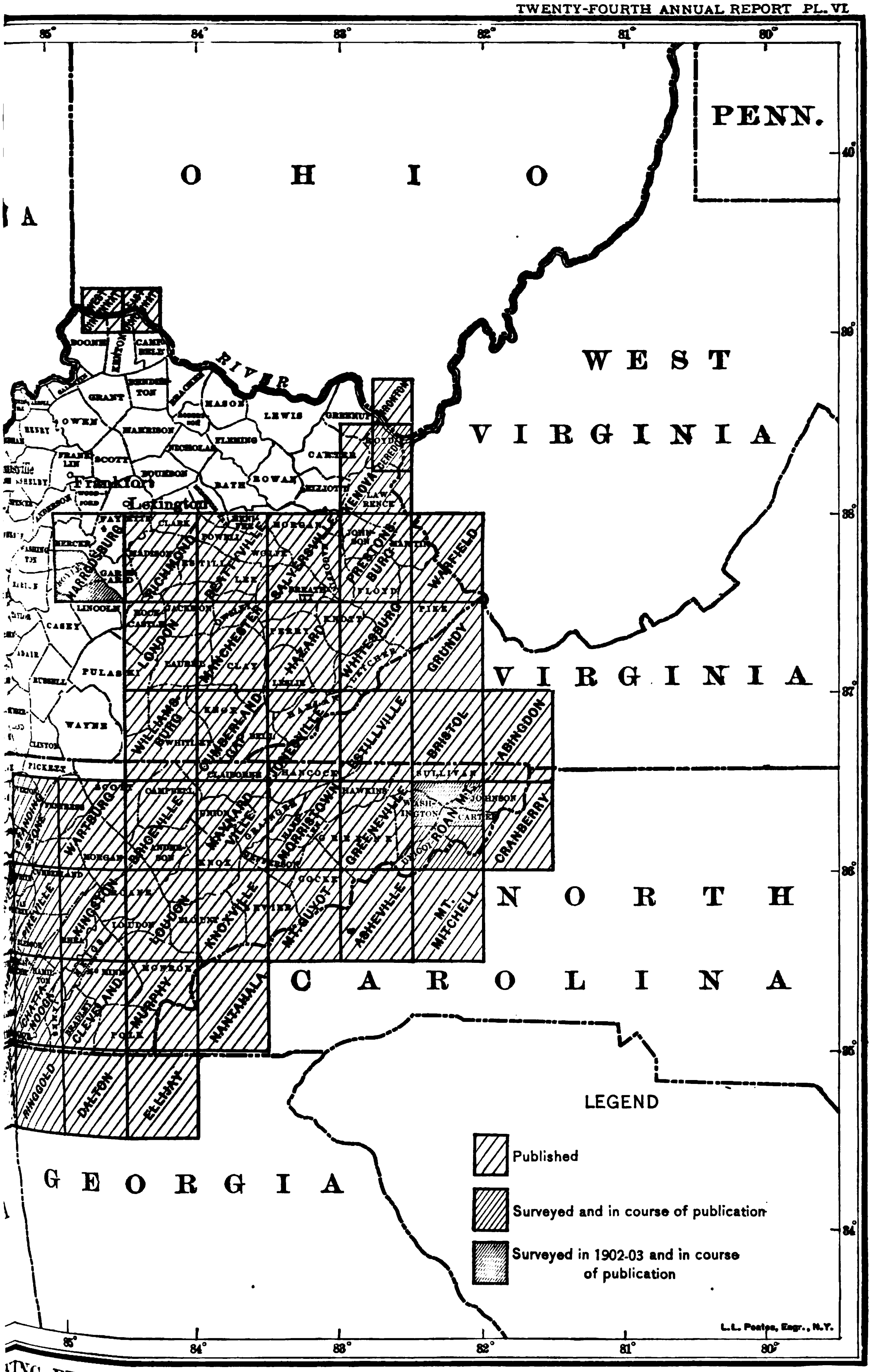
Kentucky.—Mr. W. L. Miller, topographer, was in charge of a party engaged from July to November in surveying the Harrodsburg quadrangle, in portions of Boyle, Lincoln, Doddridge, and Mercer counties. The total area surveyed was 317 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet, in connection with which 593 miles of levels were run and 7 permanent bench marks were established.

South Carolina.—Mr. Oscar Jones, topographer, was engaged from July to December in the survey of the Columbia quadrangle, in Richland, Fairfield, Newberry, Lexington, and Saluda counties. The total area surveyed was 748 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet, thus completing the quadrangle. In the course of this work 447 linear miles of levels were run.

CENTRAL SECTION.

During the season eighteen topographic field parties were employed in the States of Ohio, West Virginia, Pennsylvania, Indiana, Illinois, Kentucky, Alabama, Arkansas, Mississippi, Louisiana, Missouri, Wisconsin, Michigan, Iowa, Kansas, Nebraska, North Dakota, and Minnesota. Seventeen complete quadrangles and portions of twelve others were surveyed, covering a new area

MAP OF KENTUCKY AND TENNESSEE, SHOW



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of 7,657 square miles, of which 2,827 square miles were for publication on the scale of 1:62,500 and 4,830 square miles were for publication on the scale of 1:125,000. In addition, 1,412 square miles were resurveyed, 468 square miles being on the scale of 1:62,500 and 944 square miles on the scale of 1:125,000. Spirit levels were carried over 10,212 miles, from which 274 permanent bench marks were established.

Ohio.—Topographic work was continued in Ohio under the general plan of cooperation which was put into effect in 1901, the amount available from the State being $20,000, which was met by an equal sum from the funds of the United States Geological Survey, making a total of $40,000 for topographic work.

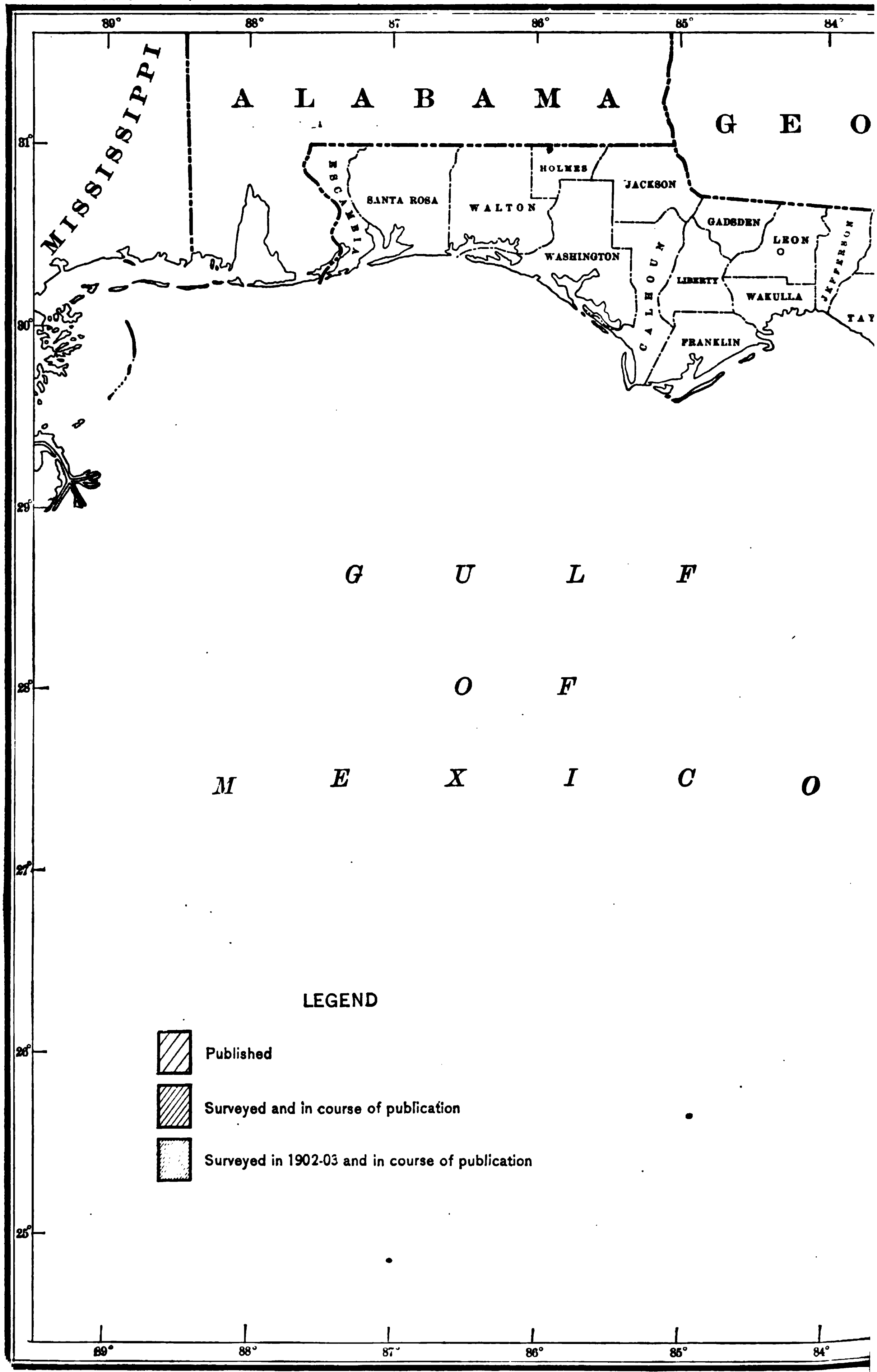
Mr. Charles E. Cooke, topographer, began field work about June 1 and continued until October 10, when he proceeded to Illinois for work hereinafter mentioned. During this period the Steubenville quadrangle, lying in parts of Jefferson County, Ohio; Hancock and Brook counties, W. Va., and Washington County, Pa., was completed. The area surveyed was 228 square miles, in connection with which 379 miles of levels were run and 12 permanent bench marks were established. Mr. Cooke was assisted during the month of June by Messrs. Basil Duke and C. W. Goodlove, topographers.

Mr. W. H. Griffin, topographer, began field work about June 1 in the Westerville quadrangle, lying immediately north of the East Columbus quadrangle, in parts of Delaware, Franklin, and Licking counties, and completed the same about August 15. Mr. Griffin then proceeded with his party to the eastern part of the State, where he began field work in the Clarington quadrangle, in Monroe and Belmont counties. The part of this quadrangle, consisting of 44 square miles, which lies in West Virginia, was surveyed in 1901. Mr. Griffin continued work until December 1, when the party was disbanded. Operations were resumed the 1st of April and the quadrangle was nearly completed by the close of the fiscal year, the sketching being done by Messrs. E. C. Bebb and Basil Duke in

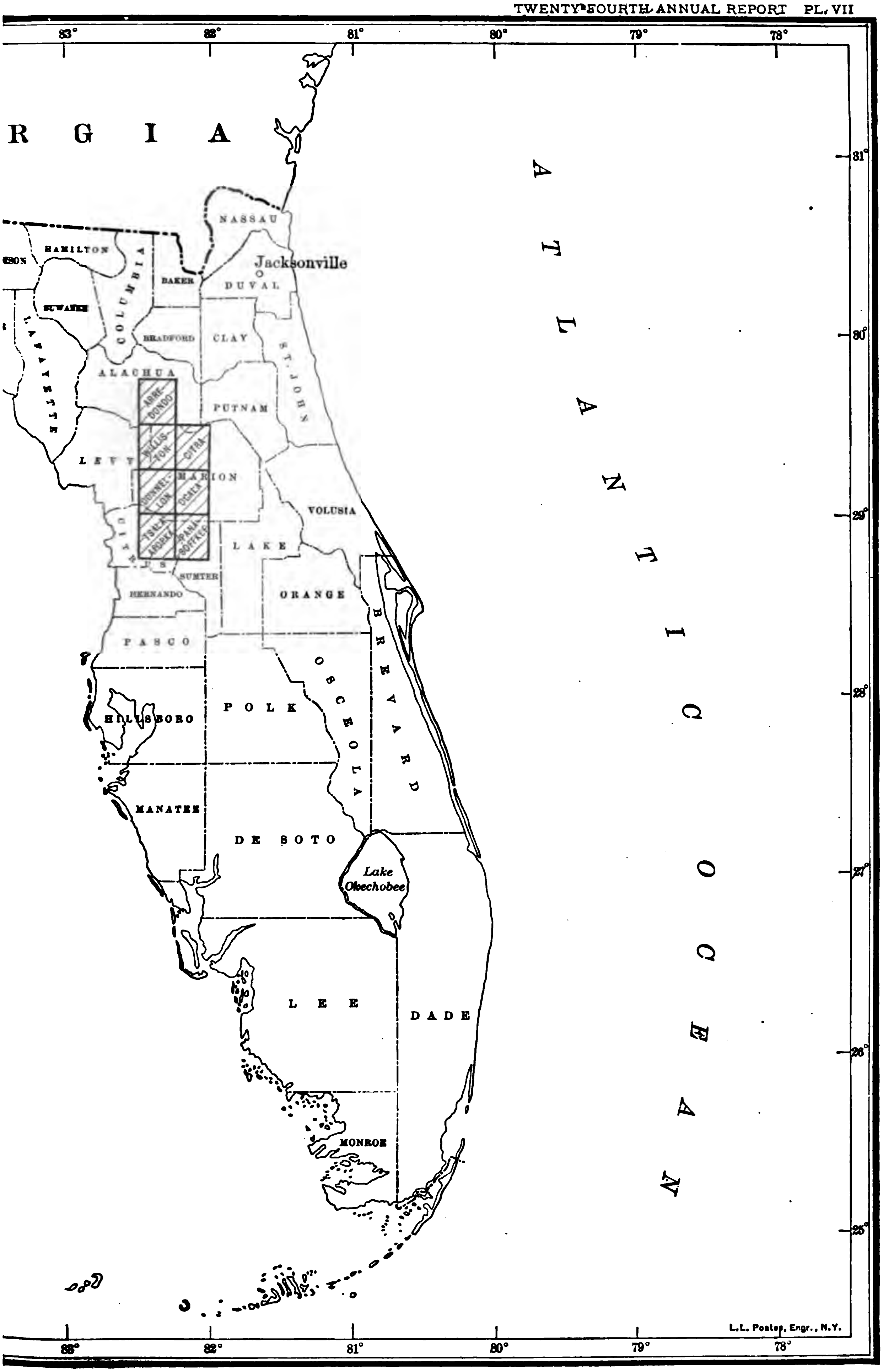
cooperation with Mr. Griffin. The total area mapped in the Westerville and Clarington quadrangles was 386 square miles, in connection with which 966 miles of levels were run and 16 permanent bench marks were established. Mr. Griffin also completed the secondary control for the Woodsfield quadrangle, lying in parts of Guernsey, Noble, Belmont, and Monroe counties, and on May 15, 1903, began the sketching, completing the mapping of 86 square miles, in connection with which 208 miles of levels were run and 9 permanent bench marks were established.

Mr. Van H. Manning, topographer, began field work about June 1 and continued until December 1, during which time the Wellsville quadrangle, lying in parts of Columbiana and Jefferson counties, Ohio, and Hancock County, W. Va., was completed and considerable progress made on the Salineville quadrangle. The portion of the Wellsville quadrangle lying in Pennsylvania, consisting of 17 square miles, was surveyed in 1901. Field work was resumed on April 1, 1903, and the Salineville quadrangle, lying in parts of Carroll, Columbiana, and Jefferson counties. About 192 square miles were mapped. The total area mapped in the two quadrangles above mentioned was 437 square miles, in connection with which 699 miles of levels were run and 17 permanent bench marks were established. Mr. Manning was assisted during June by Mr. Duncan Hannegan, topographer.

Mr. Manning also completed the secondary control for the Macksburg quadrangle, lying in parts of Noble, Washington, and Monroe counties, and early in April, 1903, Messrs. M. Hackett and C. W. Goodlove, topographers, in cooperation with Mr. Manning, commenced its mapping and completed the survey of 66 square miles, in connection with which 372 miles of levels were run and 20 permanent bench marks were established. The plane-table work on this quadrangle was done by Mr. W. N. Morrill in the fall of 1902, upon the completion of his work in the Atlantic section.



MAP OF FLORIDA, SHOWING PRO



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Mr. H. B. Blair, topographer, with his assistant, Mr. C. L. Sadler, upon the completion of his work in Missouri, began field work on the New Matamoras quadrangle, lying in parts of Monroe and Washington counties, Ohio, and Tyler County, W. Va., and continued until December 1. On April 1, 1903, Mr. Manning, with his assistant, Mr. W. J. Lloyd, topographer, resumed work in this quadrangle and completed the survey of 159 square miles by the end of June. Of the area covered, 35 square miles were surveyed by Mr. Blair and 124 square miles by Mr. Manning, in connection with which 936 miles of levels were run and 3 permanent bench marks were established.

Mr. Cummin, about May 23, resumed field work in the Berea quadrangle which had been commenced in the season of 1901, and completed the same about June 30. This quadrangle covers an area of 224 square miles in parts of Cuyahoga, Lorain, and Medina counties, and in connection with its survey 75 miles of levels were run.

Mr. W. T. Griswold, topographer, resumed field work about May 20 and continued until December 1. During this period the Scio quadrangle, embracing an area of 228 square miles in Carroll and Harrison counties, was completed and the St. Clairsville quadrangle, in Harrison, Jefferson, and Belmont counties, was commenced. Operations were resumed by Mr. Griswold, with his assistant, Mr. M. J. Munn, on April 1, in the St. Clairsville quadrangle, and 199 square miles were surveyed by the end of June. In connection with the above work 525 miles of levels were run and 7 permanent bench marks were established. Mr. Griswold also ran 167 miles of levels for the control of the Flushing quadrangle, in connection with which 5 permanent bench marks were established.

Mr. D. H. Baldwin, about October 22, began a precise line of levels for the purpose of connecting the United States Lake Survey levels with the levels of the Pennsylvania Railroad. This line extends from Cleveland to Canton, the distance run being 60 miles, in connection with which three permanent bench marks were estab-

lished. Mr. Baldwin was engaged on this work until about November 11.

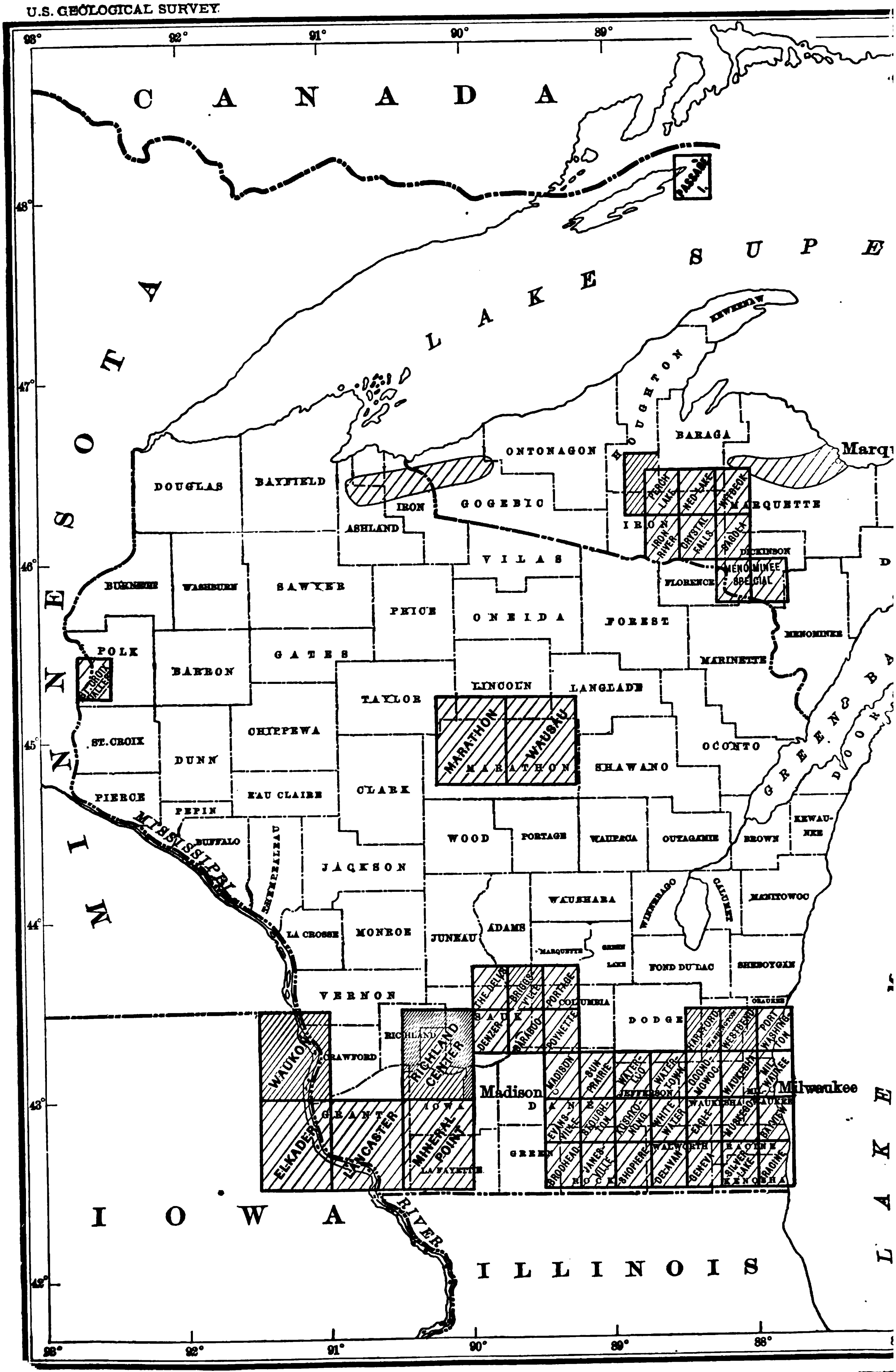
All of the topographic work in Ohio was for publication on the scale of 1: 62,500, with a contour interval of 20 feet, with the exception of that in the Westerville and Berea quadrangles, where the contour interval used was 10 feet.

Michigan.—Field work was carried on in this State under the arrangement entered into in 1901 with the State geologist, by which he allotted $2,000 to be expended in cooperation with the United States Geological Survey.

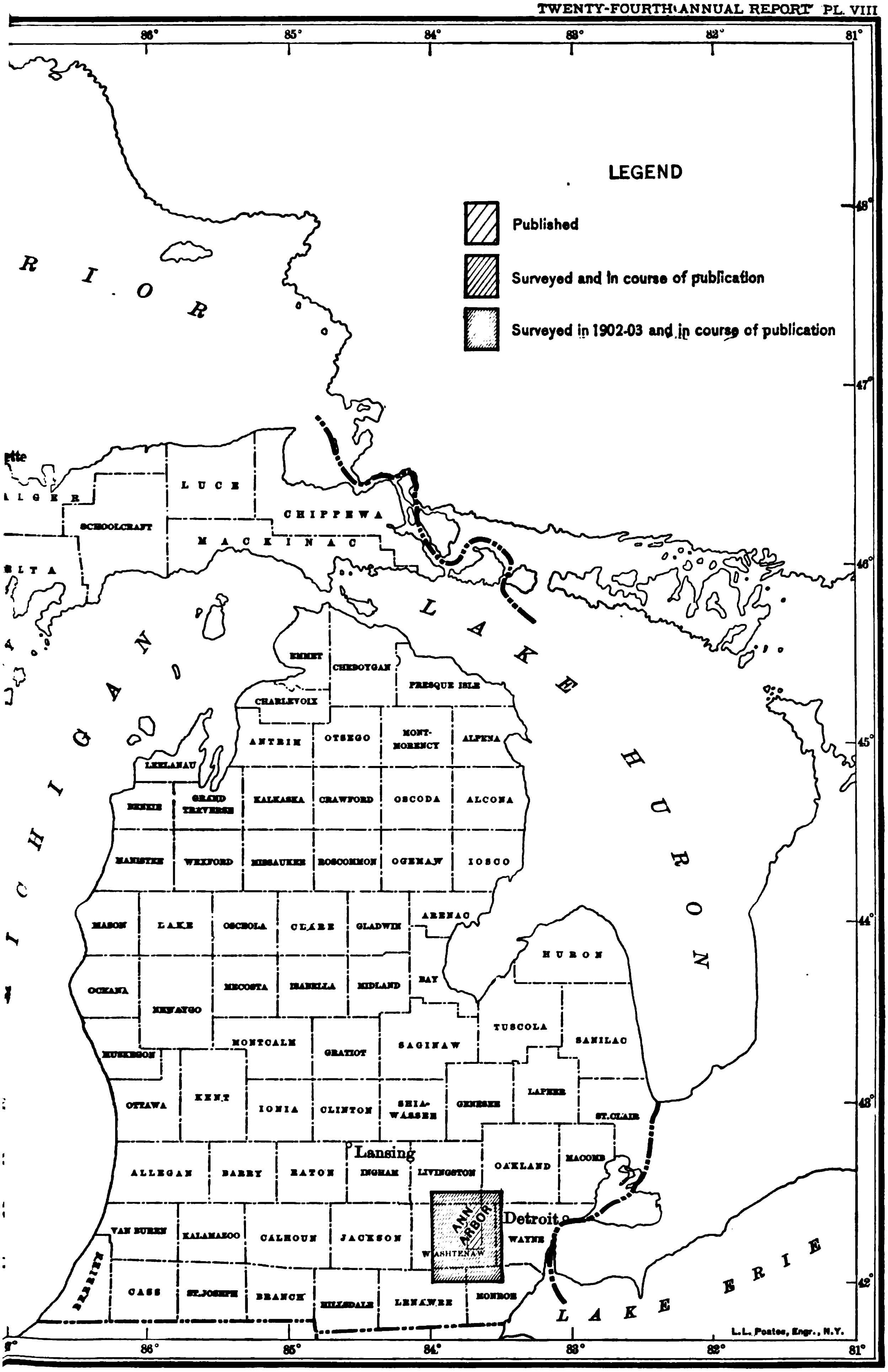
Mr. E. C. Bebb, topographer, resumed field work about the end of May in the Ann Arbor quadrangle, which was commenced in the fall of the previous year by Mr. Robert Muldrow, topographer. Mr. Muldrow joined Mr. Bebb in the early part of July and the two continued in cooperation, Mr. Muldrow until the end of October, when he was temporarily transferred to the hydrographic branch, and Mr. Bebb until December 1, when the quadrangle, lying in parts of Livingston, Oakland, Washtenaw, Wayne, Lenawee, and Monroe counties, was completed. The area mapped covers 775 square miles, 474 square miles being done by Mr. Bebb and 301 by Mr. Muldrow for publication on the scale of 1: 125,000, with a contour interval of 20 feet. In connection with the topographic work 1,116 miles of levels were run and 21 permanent bench marks were established.

Wisconsin.—Mr. R. C. McKinney, topographer, upon the completion of his work in Nebraska, about October 15, began field work in the Richland Center quadrangle and continued until the 16th of November, when 82 square miles in Richland and Iowa counties were completed, for publication on the scale of 1: 125,000, with a contour interval of 20 feet. In connection with this work 39 miles of levels were run and 8 permanent bench marks were established.

For the purpose of developing the possibilities of the storage and power of the waters of the Chippewa River, primary level work was commenced about April 15, 1903,



MAP OF MICHIGAN AND WISCONSIN, SHOWI



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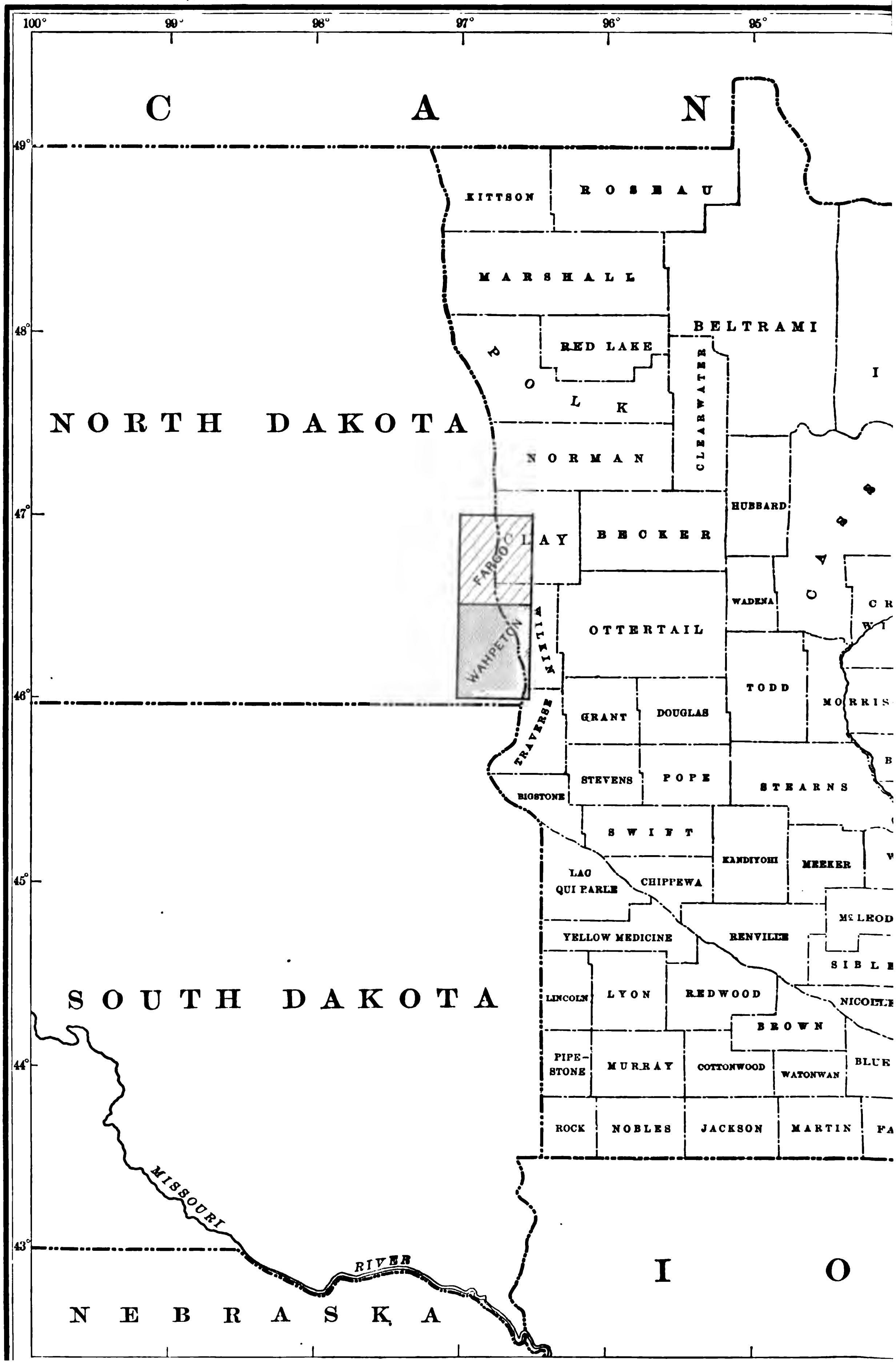
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NORMAN
CLAY
FARGO
WAHPETON
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HUBBARD
WADENA
OTTERTAIL
WILKIN
TRAVERSE
GRANT
DOUGLAS
TODD
STEVENS
POPE
STEARNS
BIGSTONE
SWIFT
KANDIYOHI
MEEKER
LAC QUI PARLE
CHIPPEWA
YELLOW MEDICINE
RENVILLE
LINCOLN
LYON
REDWOOD
BROWN
PIPE-STONE
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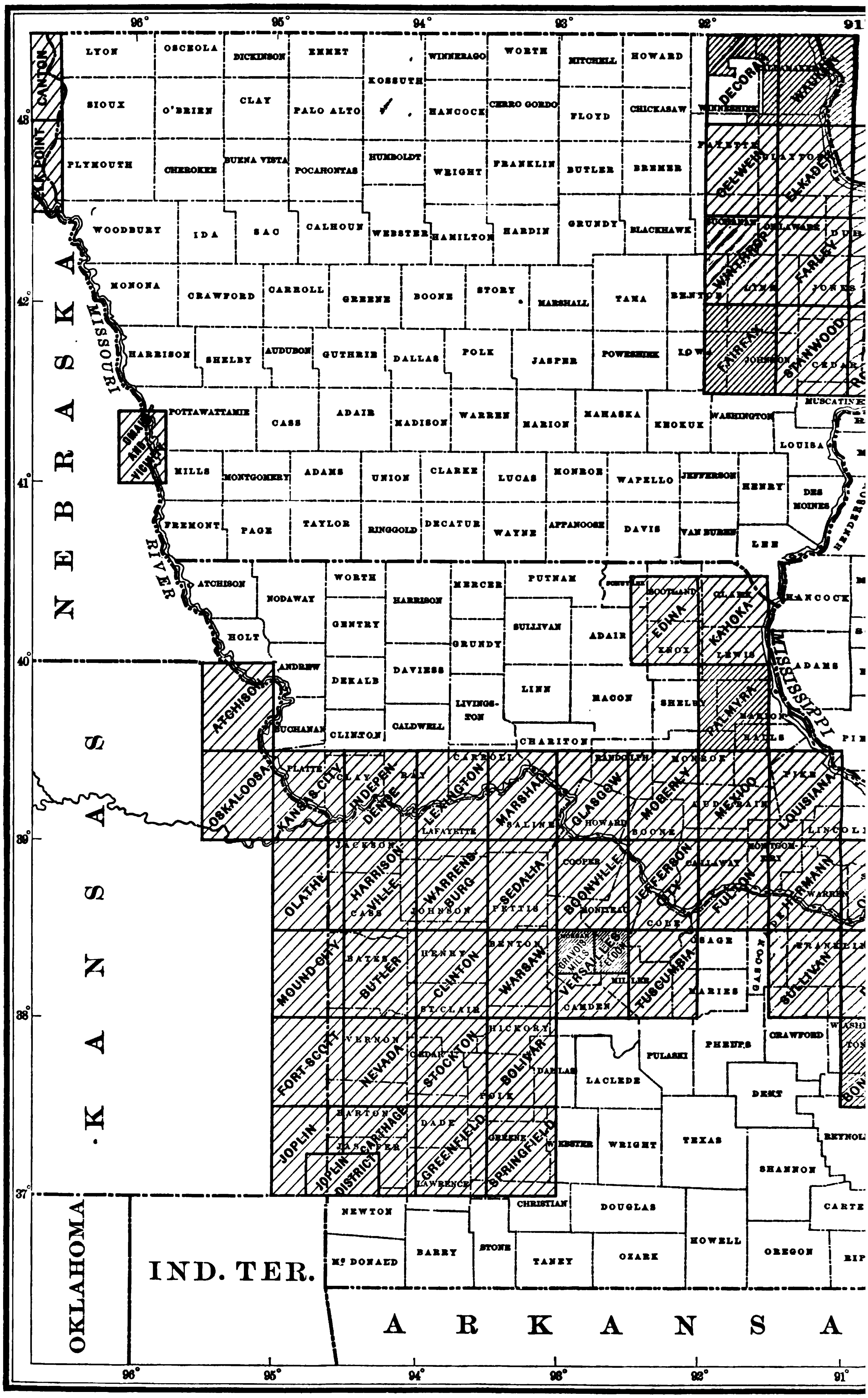
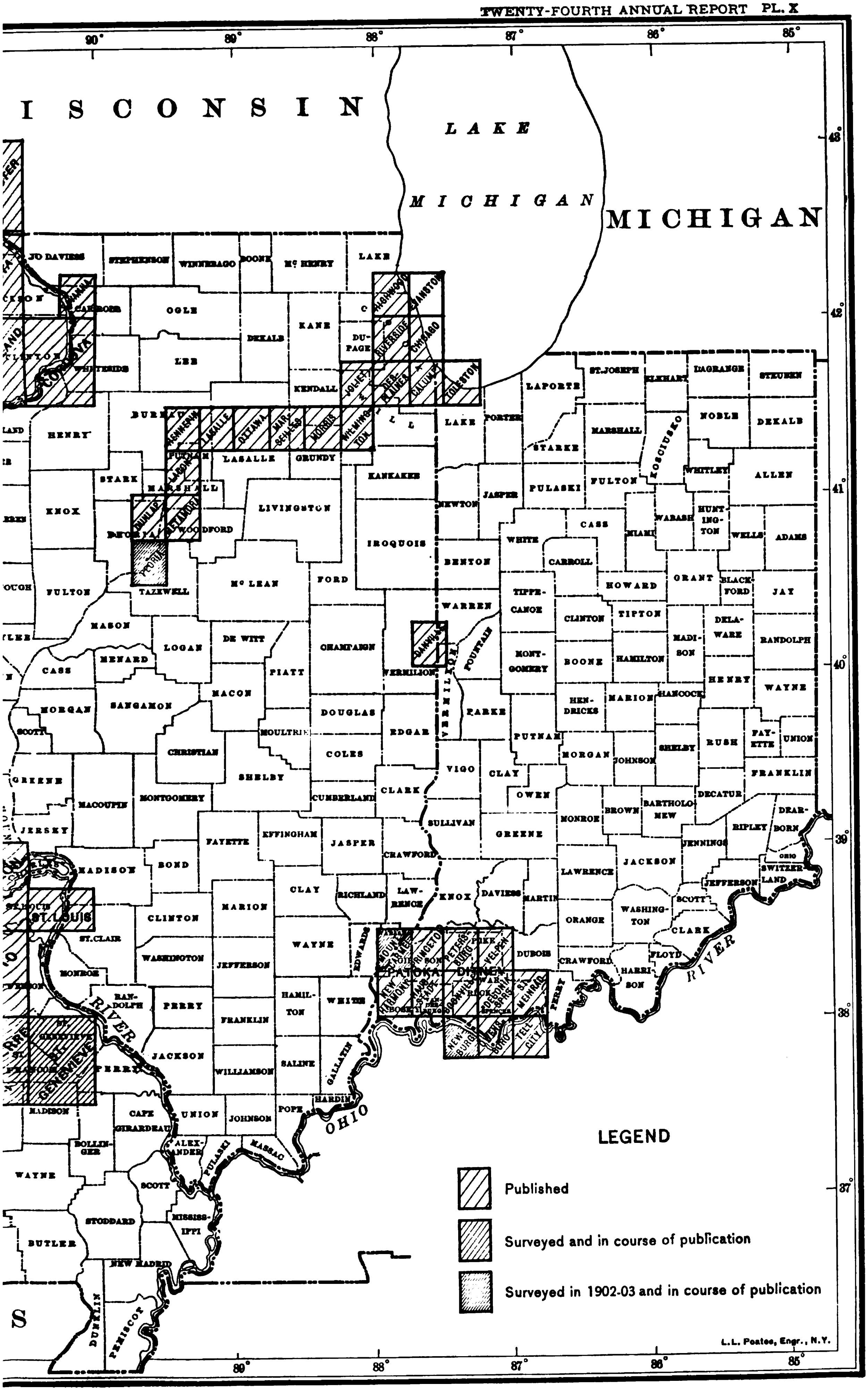


MAP OF INDIANA, ILLINOIS, IOWA, AND MISSOURI.



SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

at the mouth of the river, and extended to Eau Claire and Chippewa Falls, by Mr. J. R. Ellis. This line, 69 miles long, was completed early in June, and in connection with it 11 permanent bench marks were established.

North Dakota-Minnesota.—Mr. J. T. McCoy, field assistant, upon the completion of his duties in Michigan, about the 1st of August, began field work in North Dakota, and continued in this district until the end of October, when the Wahpeton quadrangle, lying in parts of Wilkin and Traverse counties, Minn., and Richland County, N. Dak., was completed. The area surveyed was 827 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet, in connection with which 557 miles of levels were run and 21 permanent bench marks were established. Mr. McCoy, upon the completion of this work, proceeded to Ohio to assist Mr. Manning.

Nebraska.—Field work was commenced in the Weeping Water quadrangle, lying in parts of Cass, Otoe, Johnson, Nemaha, and Lancaster counties, about July 1, and continued until about October 9, when the quadrangle was completed, the north half, consisting of 452 square miles, being mapped by Mr. R. C. McKinney, and the south half, consisting of 453 square miles, being mapped by Mr. M. Hackett. The total area surveyed was 905 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet, in connection with which 721 miles of levels were run and 17 permanent bench marks were established.

Iowa.—Mr. Hackett, upon the completion of his work in Nebraska, about October 15, began field work in the Decorah quadrangle, which lies in parts of Winnisheik, Fayette, and Allamakee counties, and continued until about November 15, when 118 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet, were completed. In connection with this work 129 miles of levels were run.

Illinois.—Mr. C. E. Cooke, upon the completion of his work in Ohio about October 15, began the mapping of

the Peoria quadrangle, in Peoria and Tazewell counties, and continued until December 18, when 157 square miles, for publication on the scale of 1: 62,500, with a contour interval of 10 feet, were completed. Operations were resumed on June 1, and the quadrangle was completed at the end of the month. The total area surveyed was 227 square miles, in connection with which 646 miles of levels were run and 15 permanent bench marks were established.

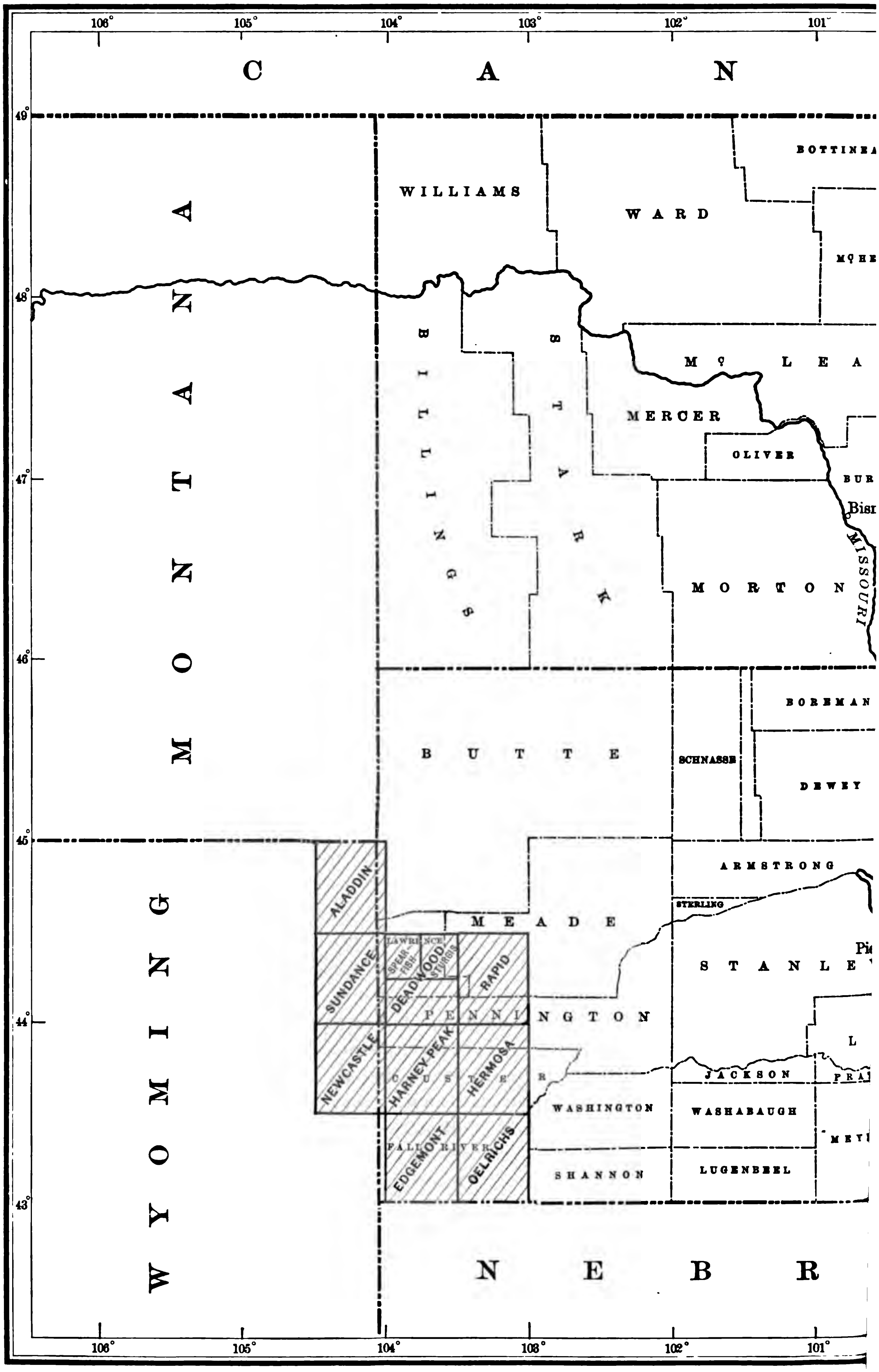
Indiana-Illinois.—Mr. C. W. Goodlove, topographer, began field work about July 1 in the Mount Carmel quadrangle, lying in parts of Wabash County, Ill., and Gibson County, Ind. The quadrangle, consisting of 234 square miles, was completed about September 15, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In connection with this work 432 miles of levels were run and 11 permanent bench marks were established.

Indiana-Kentucky.—Upon the completion of the work above mentioned, Mr. Goodlove commenced the survey of the Newburg quadrangle. Work was continued until the end of December, when 200 square miles of the Newburg and 50 square miles of the Beech Grove quadrangles were completed, in parts of Daviess, Henderson, Webster, and McLean counties, Ky. This work was for publication on the scale of 1:62,500, with a contour interval of 20 feet, and in connection with it 348 miles of levels were run.

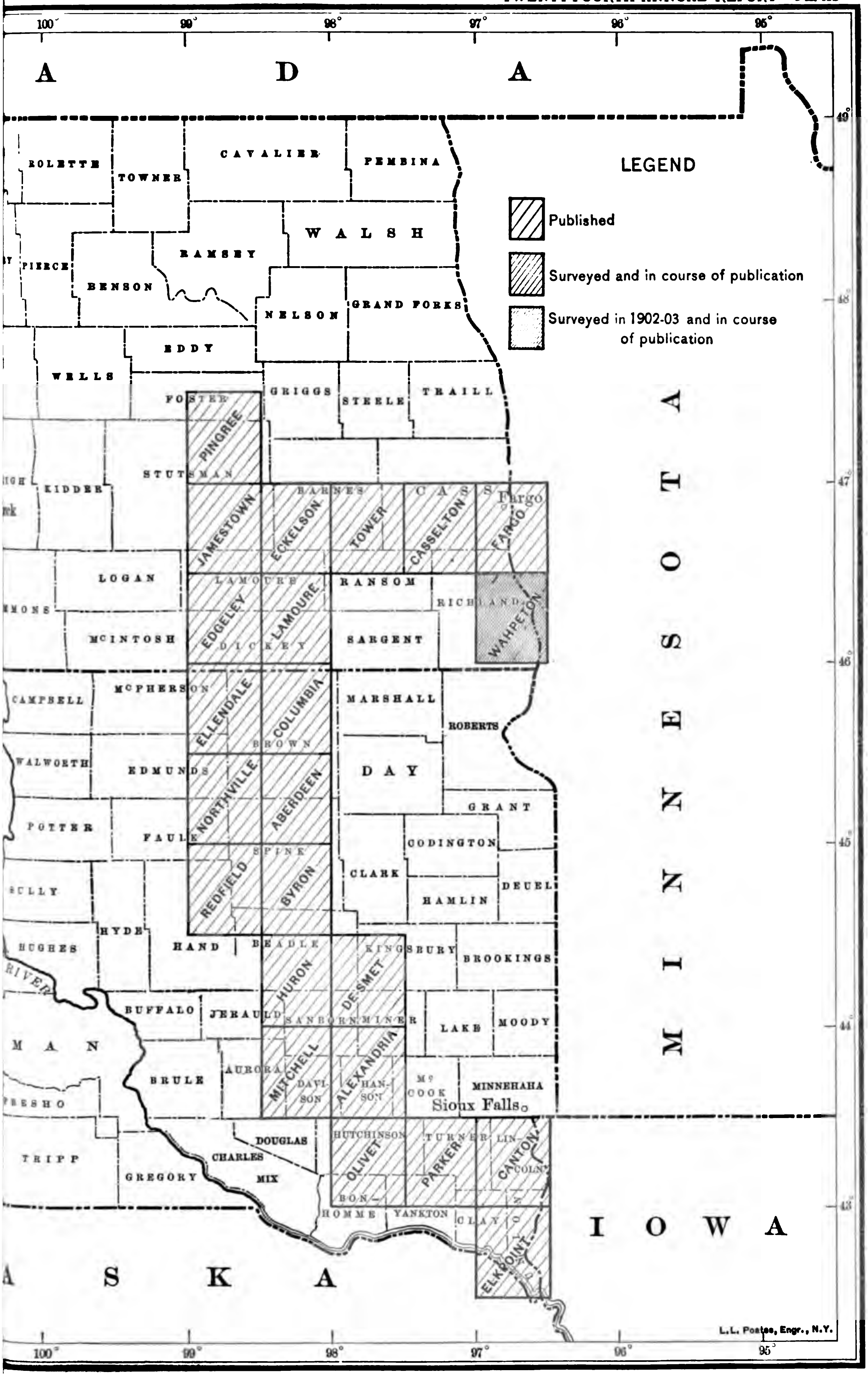
Kansas.—Mr. Basil Duke, topographer, began field work about July 1 on the resurvey of the Iola quadrangle, in parts of Allen, Neosho, Bourbon, and Crawford counties, and continued until the end of October, when he proceeded to Ohio for further duty with Mr. Griffin. During this period the Iola quadrangle, consisting of 944 square miles, was completed for publication on the scale of 1:125,000, with a contour interval of 20 feet. In connection with this work 568 miles of levels were run and 24 permanent bench marks were established.

Missouri.—Mr. Blair began field work about July 15 and continued until the 1st of November, when he proceeded to Ohio for work hereinbefore mentioned. Dur-

U.S. GEOLOGICAL SURVEY



MAP OF NORTH DAKOTA AND SOUTH DAKOTA,



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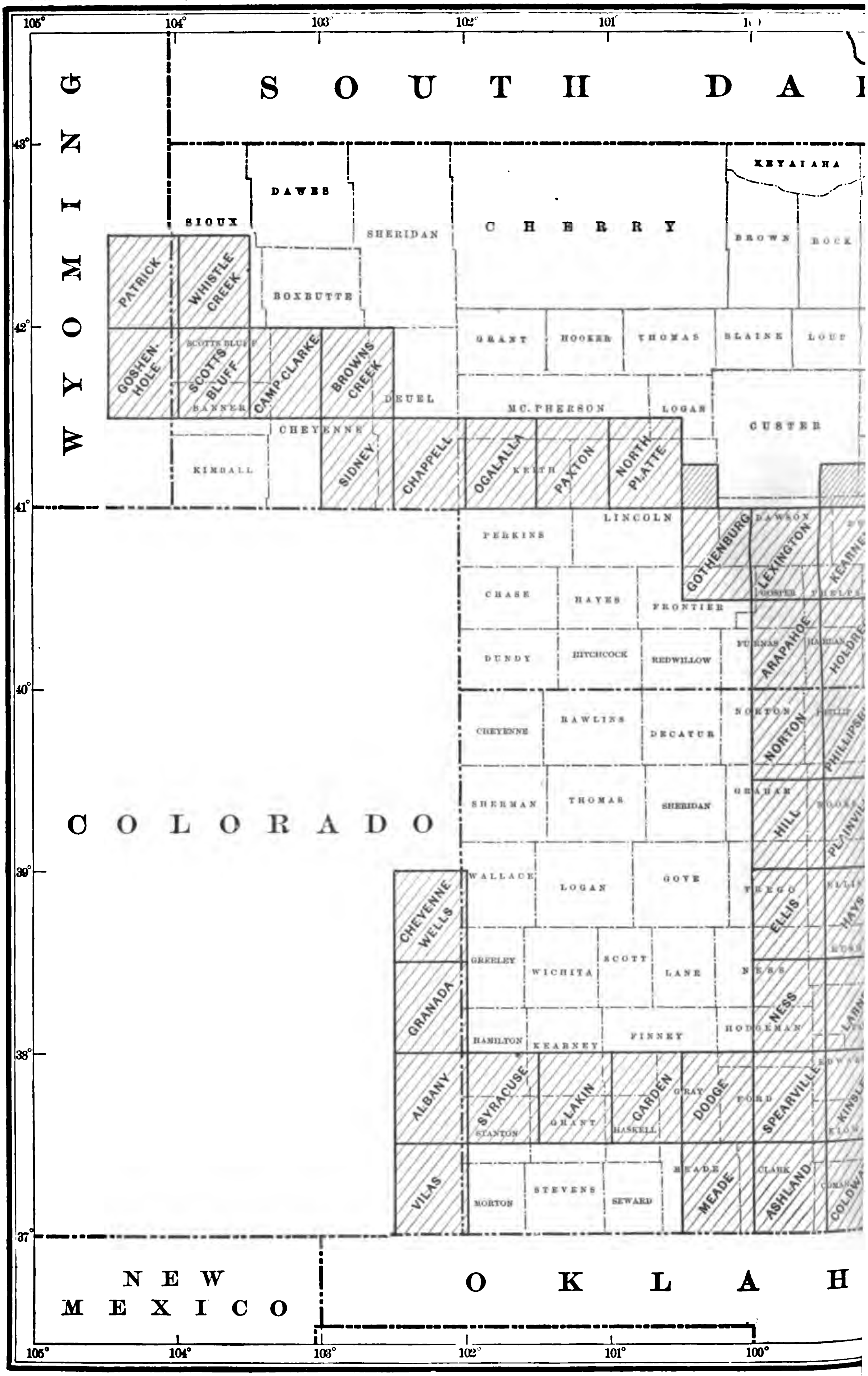
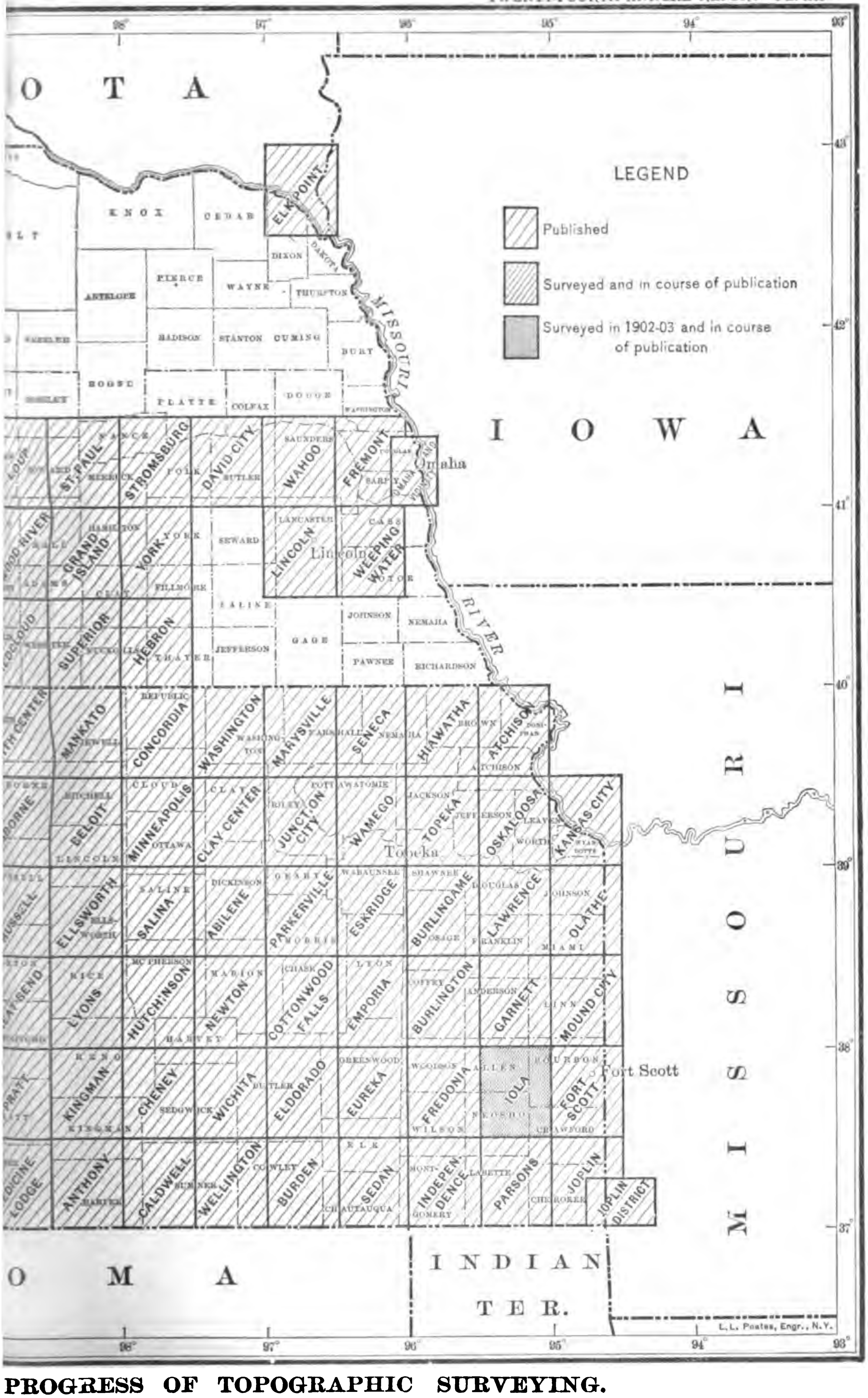
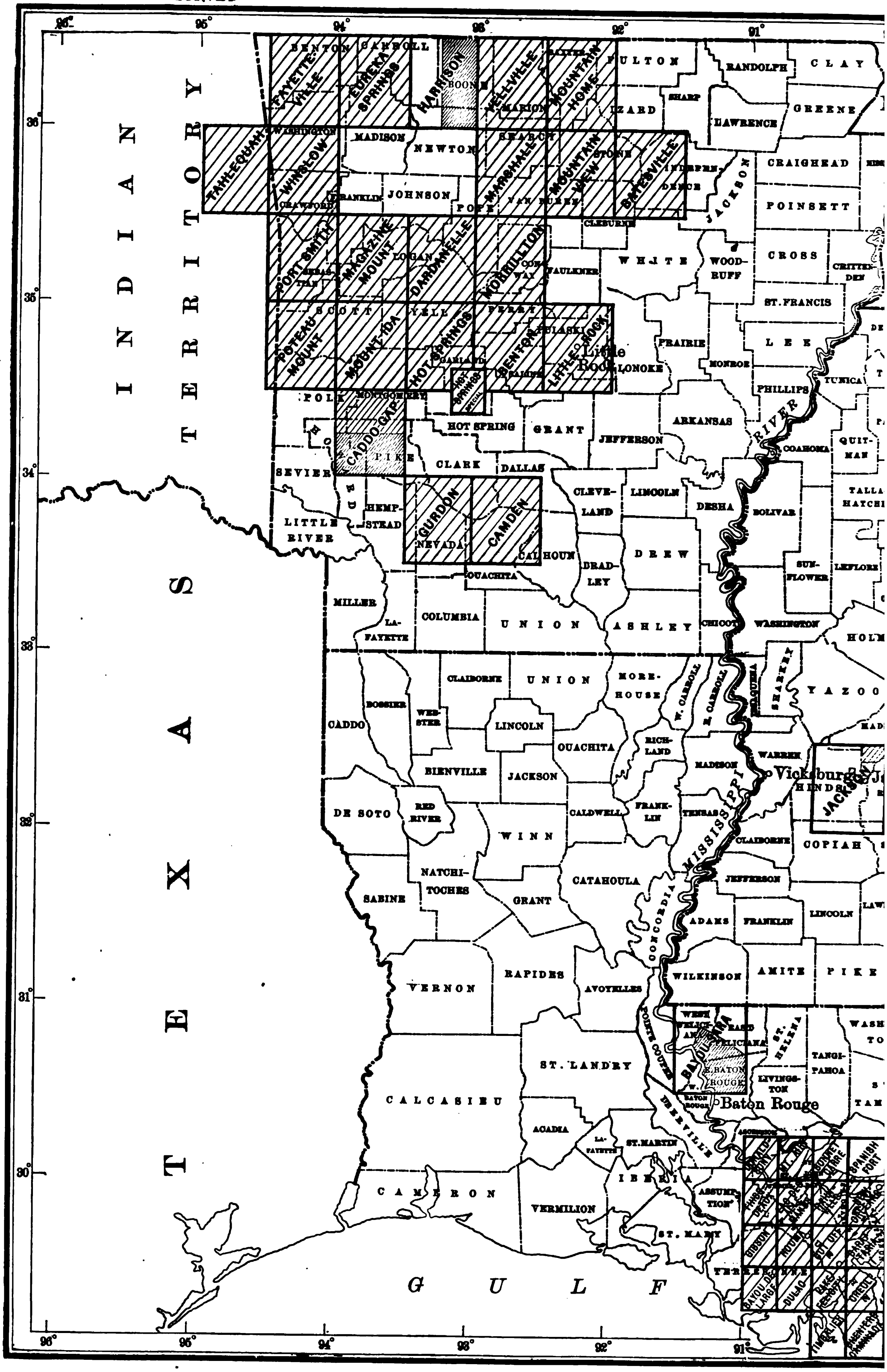


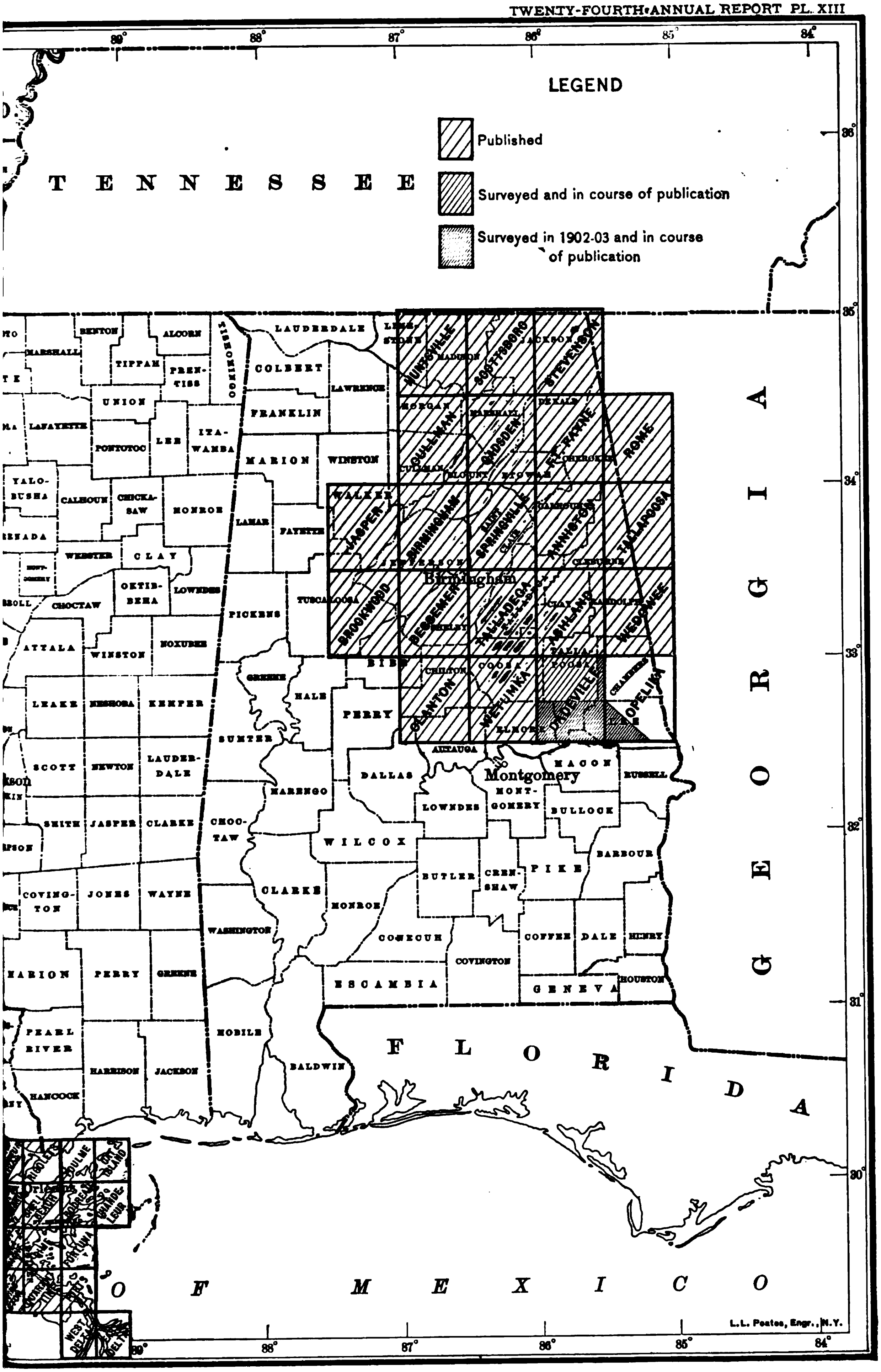
MAP OF NEBRASKA AND KANSAS, SHOWI



PROGRESS OF TOPOGRAPHIC SURVEYING.



MAP OF ALABAMA, MISSISSIPPI, ARKANSAS, AND LOUISI



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ing this period the Gravois Mills and Eldon quadrangles, embracing an area of 468 square miles, in parts of Moniteau, Miller, and Morgan counties, were completed for publication on the scale of 1:62,500, with a contour interval of 20 feet. In connection with this work 439 miles of levels were run and 16 permanent bench marks were established.

Arkansas.—Field work was commenced in the northern part of the State about July 1 by Mr. Hannegan and was continued until about the middle of November, during which time the east half of the Harrison quadrangle, covering an area of 463 square miles in parts of Boone and Newton counties, was completed. In connection with this work 229 miles of levels were run and 10 permanent bench marks were established. Upon the completion of this work Mr. Hannegan proceeded with his party to the southwestern part of the State and resumed work in the Caddo Gap quadrangle, which was commenced the year before by Mr. Blair. Mr. Hannegan continued in this vicinity until about the middle of March, when the quadrangle was completed, and he proceeded with his party to Louisiana for further duty. The area mapped in the Caddo Gap quadrangle was 658 square miles, in Howard and Pike counties, in connection with which 229 miles of levels were run and 14 permanent bench marks were established. All of the work in Arkansas was for publication on the scale of 1:125,000, with a contour interval of 50 feet.

Louisiana.—Work was prosecuted in Louisiana under an agreement between the Director of the United States Geological Survey and the director of the Louisiana Experiment Station, by which $2,500 was allotted from the funds of the latter, to be met by a like amount from the Geological Survey.

Upon the completion of his work in Arkansas, Mr. Hannegan with his party removed to Louisiana and began the survey of the Bayou Sara quadrangle, in East and West Baton Rouge and East and West Feliciana parishes. Work was continued until May 15, when 110

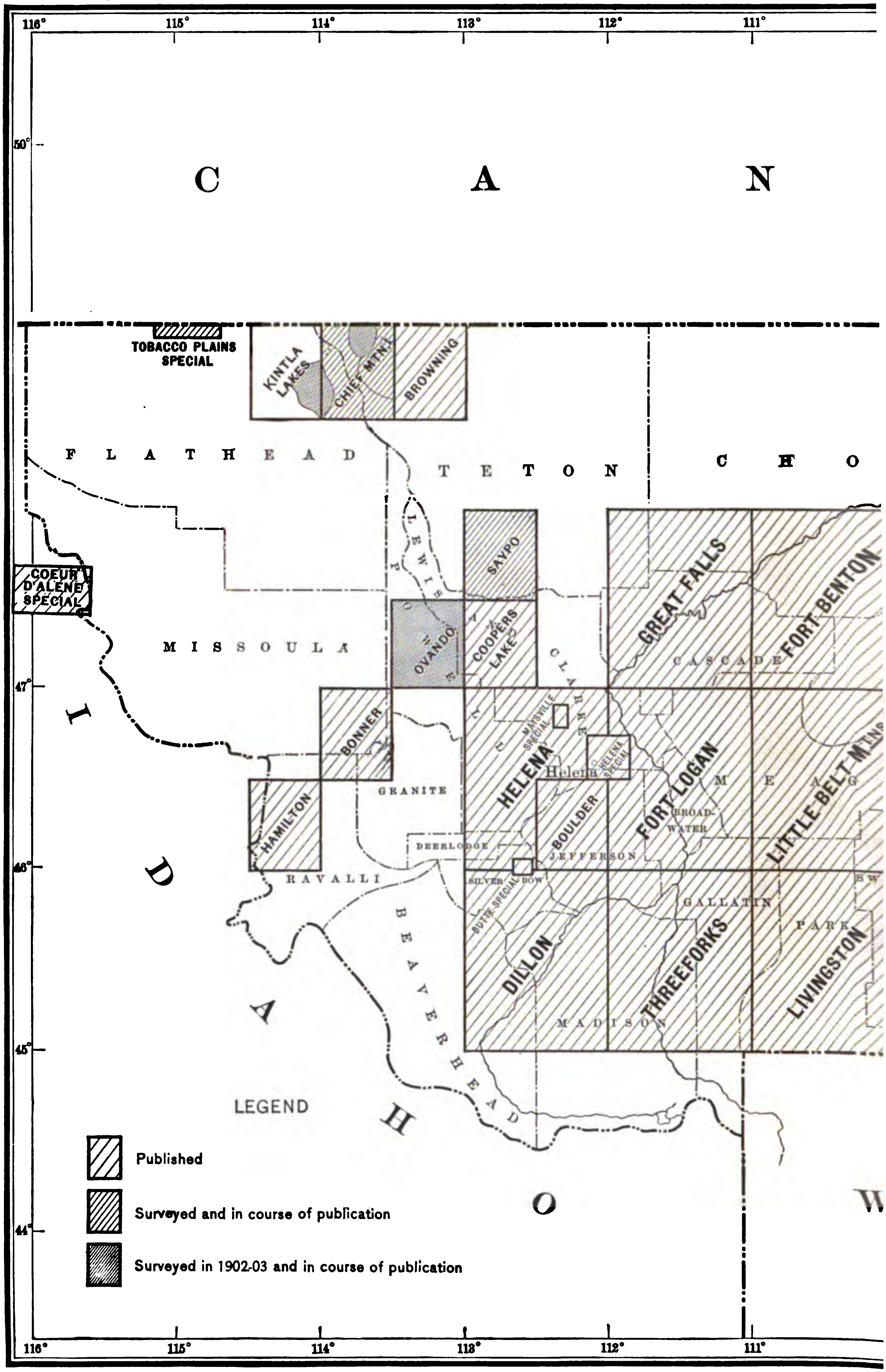
square miles were completed, for publication on the scale of 1:125,000, with a contour interval of 20 feet. In connection with this work 369 miles of levels were run and 8 permanent bench marks were established.

Mississippi.—Field work in Mississippi was resumed under the agreement with the director of the Mississippi Experiment Station, by which he allotted $1,000 for cooperative topographic work, to be met by a like amount by the Director of the United States Geological Survey. Work was in charge of Mr. Carl L. Sadler, assistant topographer, who began December 1 and continued until March 1, during which time all roads, drainage, and houses were platted over 810 square miles of the Jackson quadrangle, in Yazoo, Madison, Hinds, Rankin, Copiah, and Simpson counties.

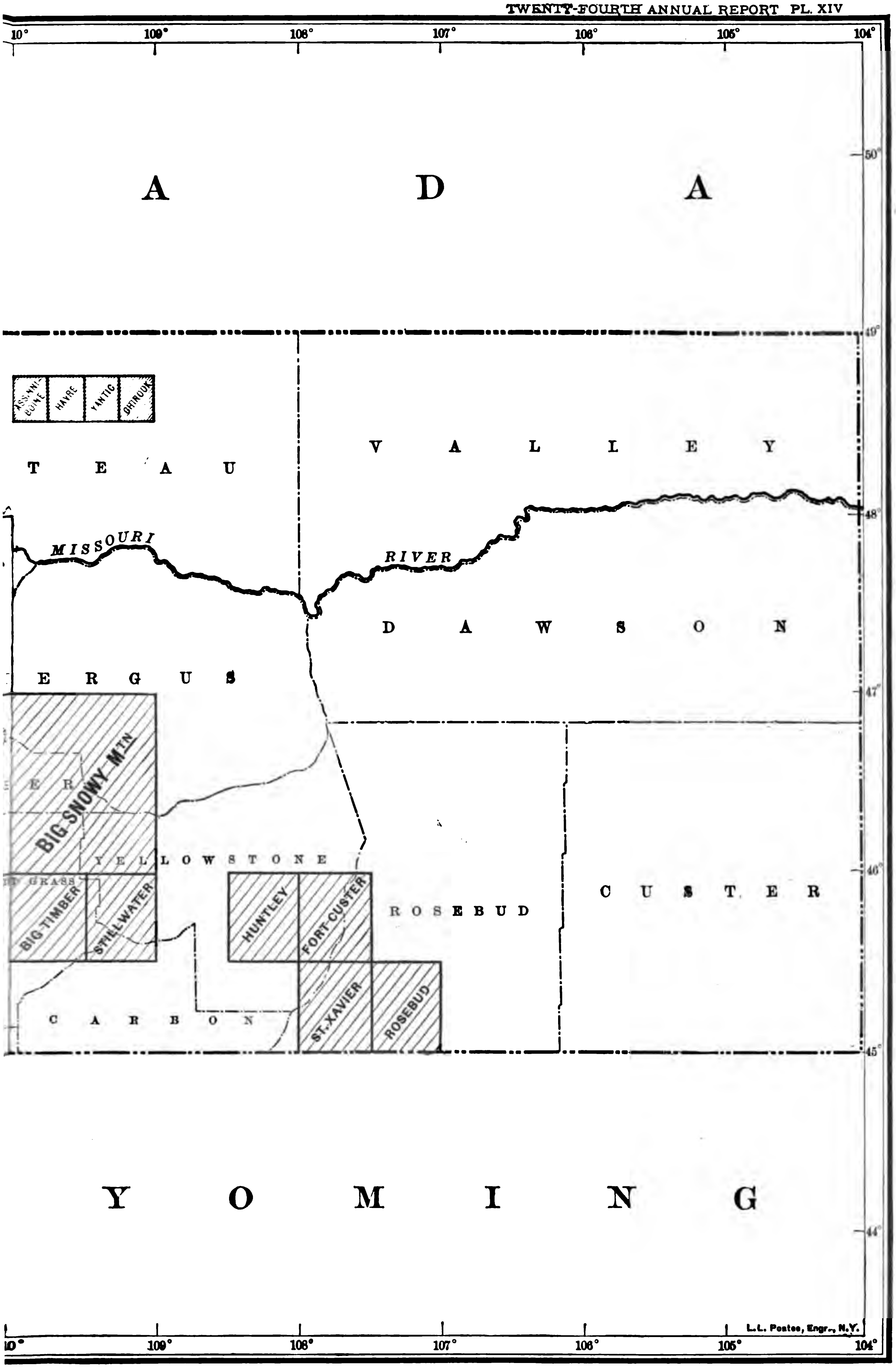
Alabama.—The agreement with the State geologist was continued, by which he contributed $1,000 from his funds, to be expended in cooperation with the United States Geological Survey. Mr. Paul Holman, topographer, was detailed to resume work in the Dadeville quadrangle, which had been commenced by Mr. Muldrow in the season of 1902, and began on July 20, continuing in this vicinity until the early part of November. An area of 587 square miles was mapped, thus completing the Dadeville quadrangle and also 305 square miles in the Opelika quadrangle. This work lies in parts of Elmore, Tallapoosa, Macon, and Lee counties, and is for publication on the scale of 1:125,000, with a contour interval of 50 feet. In connection with the above 398 miles of levels were run and 16 permanent bench marks were established.

ROCKY MOUNTAIN SECTION.

Topographic work was carried on during the season by eleven parties in Montana, Wyoming, Colorado, Utah, Arizona, Indian Territory, and Texas, which resulted in the completion of eleven quadrangles and two special maps and the partial survey of three quadrangles. The total new area surveyed was 4,329 square miles, of which

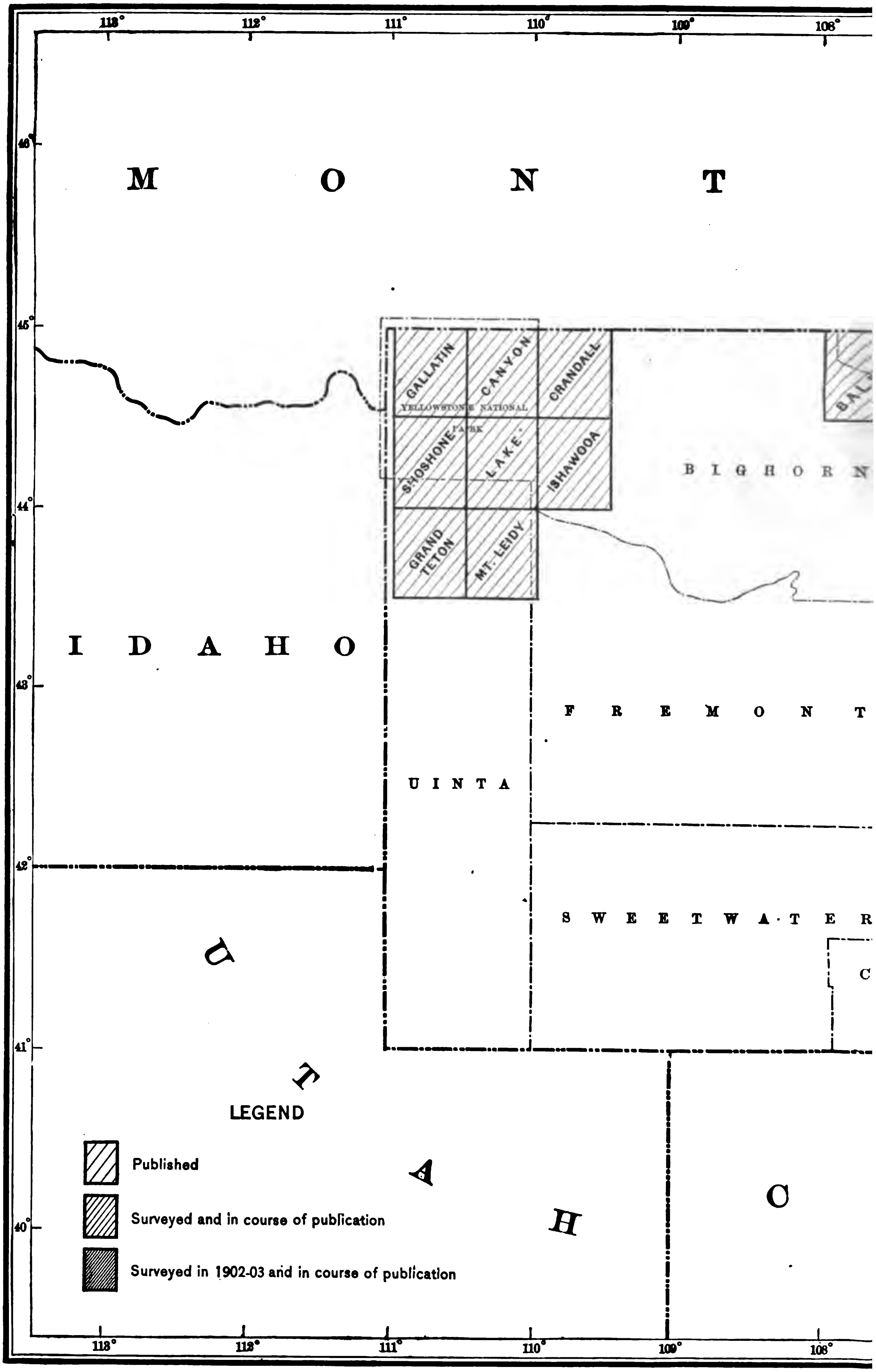


MAP OF MONTANA, SHOWING PROG

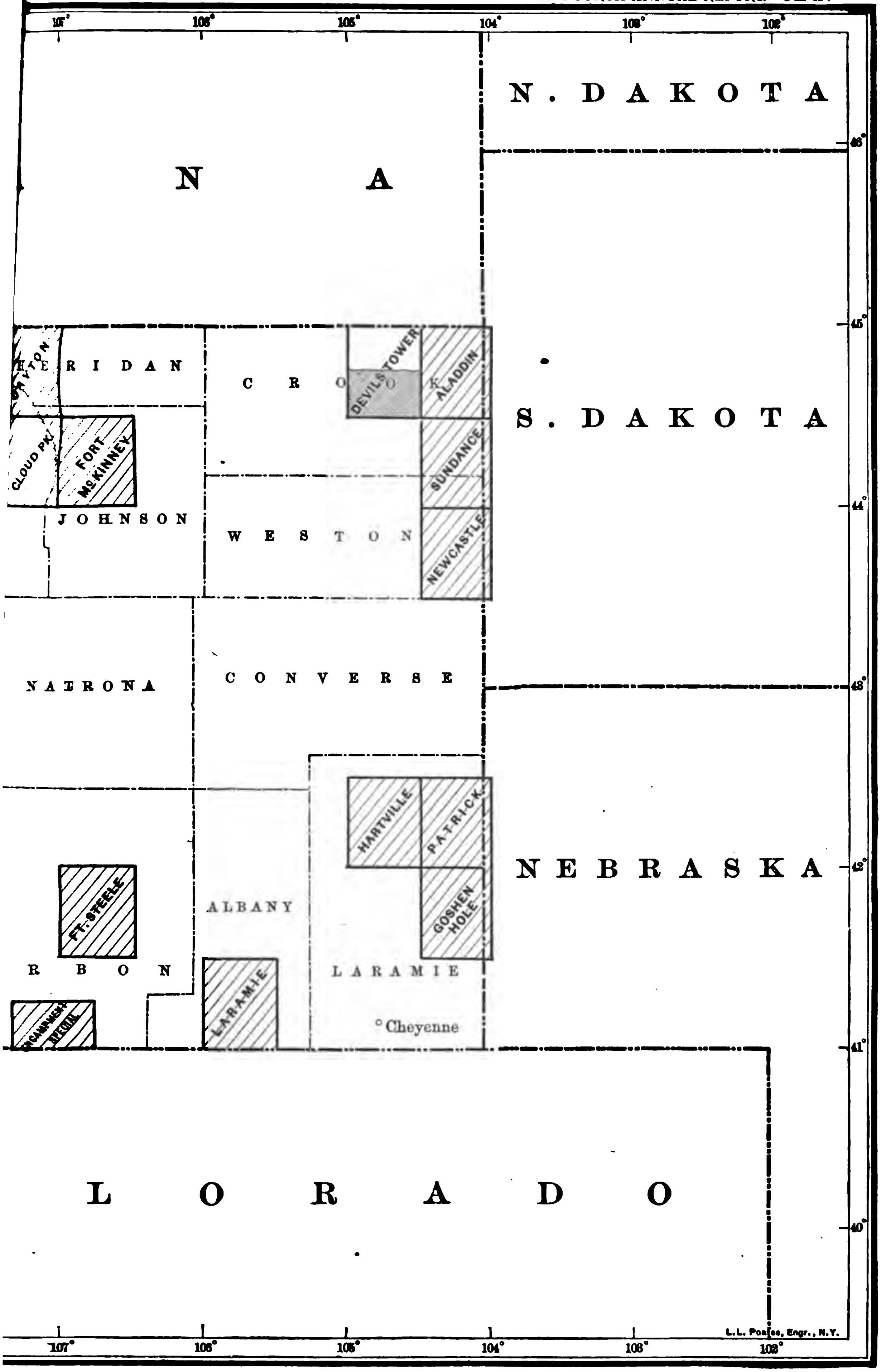


RESS OF TOPOGRAPHIC SURVEYING.

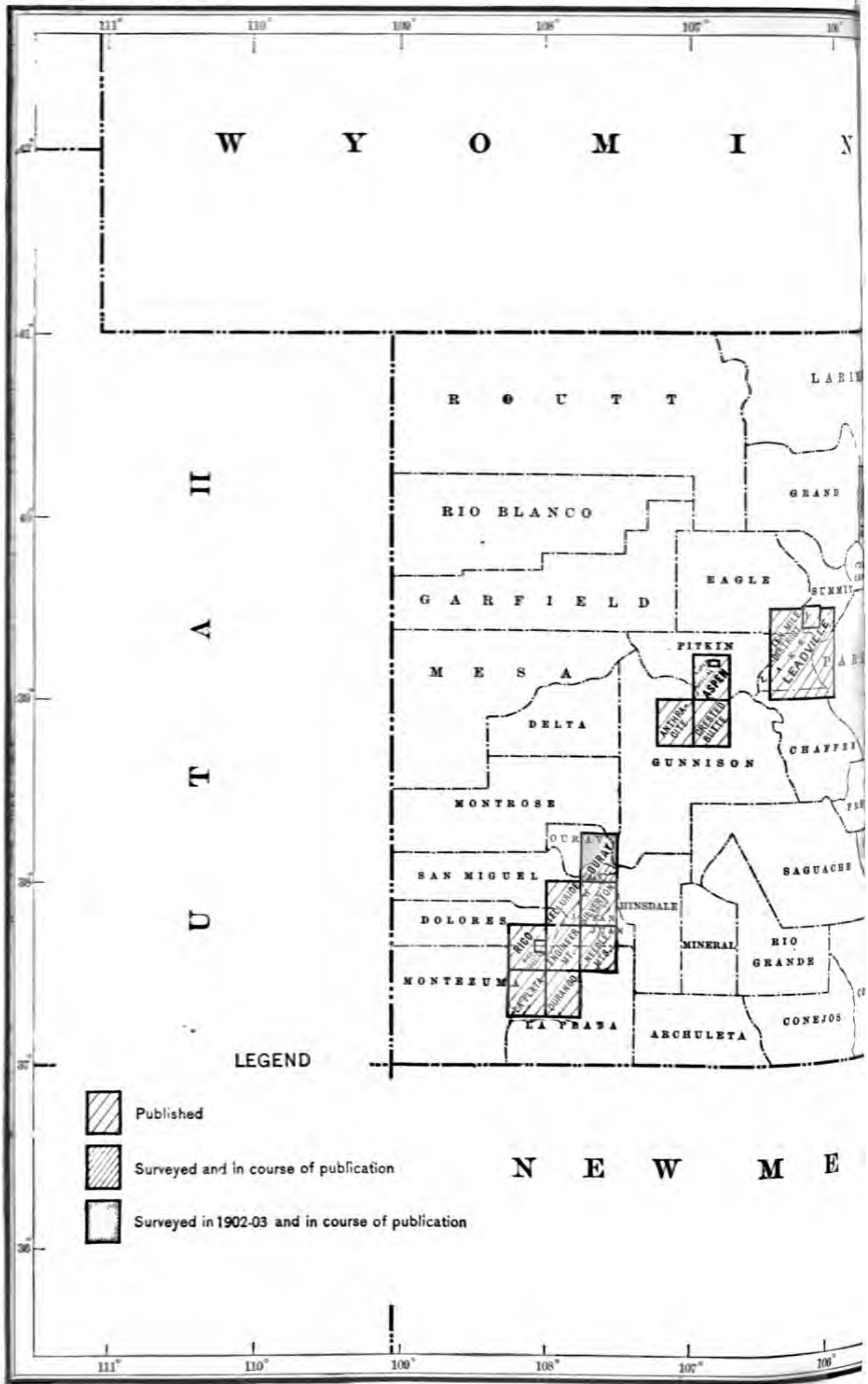
U.S. GEOLOGICAL SURVEY



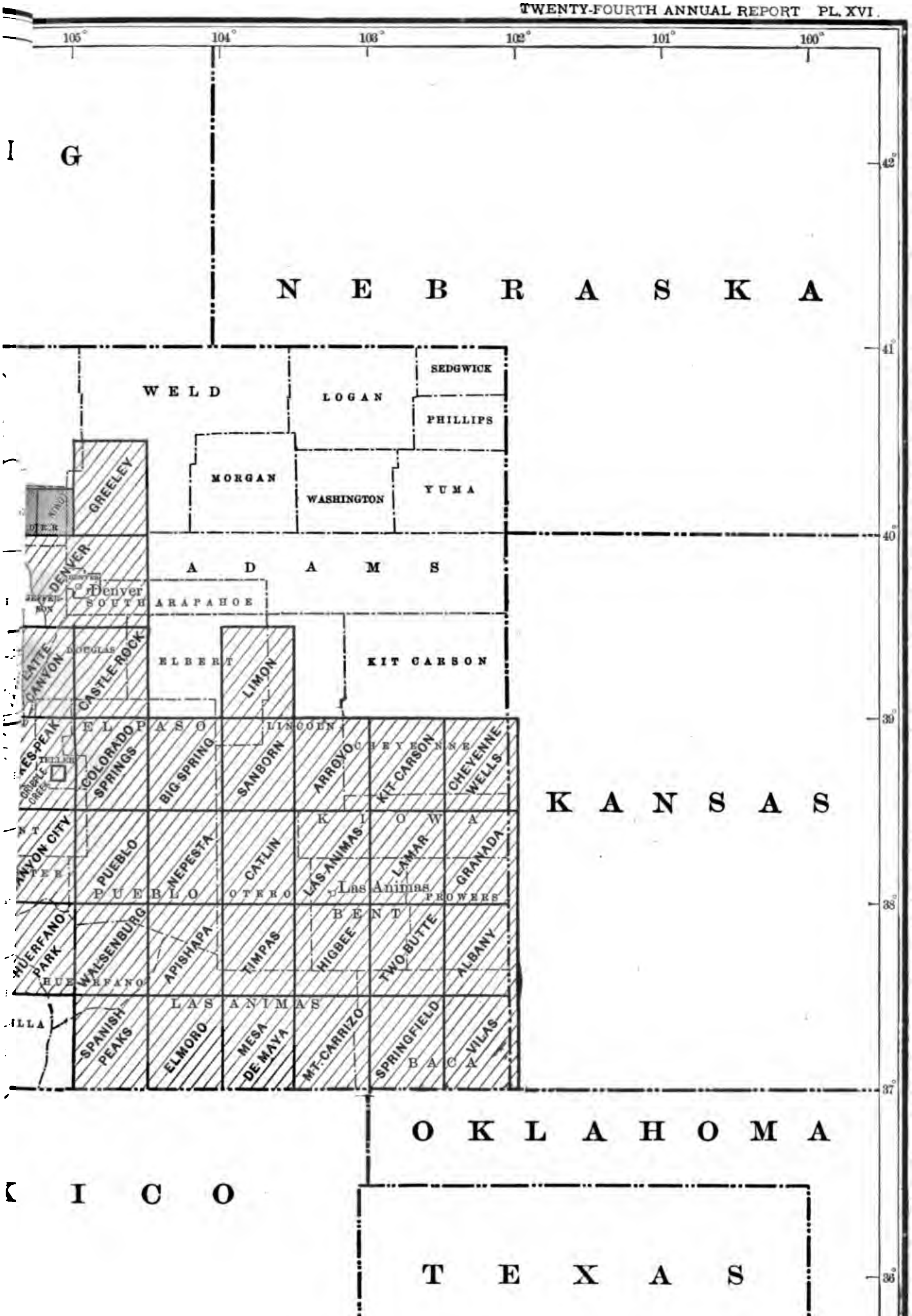
MAP OF WYOMING, SHOWING PRO



ESS OF TOPOGRAPHIC SURVEYING.



MAP OF COLORADO, SHOWING PRO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MORGAN
WASHINGTON
YUMA
GREELEY
ADAMS
DENVER
Denver
SOUTH ARAPAHOE
ELBERT
KIT CARSON
DOUGLAS
CASTLE ROCK
LIMON
EL PASO
LINCOLN
COLORADO SPRINGS
BIG SPRING
SANBORN
ARROYO
CHEYENNE
KIT-CARSON
CHEYENNE WELLS
K A N S A S
CANYON CITY
PUEBLO
NEPESTA
CATLIN
LAS-ANIMAS
LAMAR
GRANADA
KIOWA
Las Animas
PUEBLO
OTERO
PROWERS
BENT
HUERFANO PARK
WALSENBURG
APISHAPA
TIMPAS
HIGBEE
TWO-BUTTE
ALBANY
HUERFANO
LAS ANIMAS
SPANISH PEAKS
ELMORO
MESA-DE-MAYA
MT-CARRIZO
SPRINGFIELD
VILAS
BACA
O K L A H O M A
I C O
T E X A S
L.L. Poates, Engr., N.Y.

2,513 square miles were for publication on the scale of 1:125,000, 1,751 square miles were for publication on the scale of 1:62,500, and 65 square miles were for publication on the scale of 1:50,000. In addition, 86 square miles were resurveyed, 26 square miles of which were on the scale of 1:25,000, and 60 square miles on the scale of 1:125,000. In connection with this work 1,324 linear miles of levels were run, and 367 permanent bench marks were established.

Montana.—Mr. H. L. Baldwin, jr., on July 15 organized three topographic parties, under Messrs. H. H. Hodgeson, assistant topographer; E. R. Bartlett and J. E. Blackburn, field assistants; and two level parties, under Messrs. M. S. Bright and H. F. Burkart. During the season the mapping of the Fort Assinniboine, Havre, Yantic, and Chinook quadrangles, in Choteau County, was completed for publication on the scale of 1:62,500, with a contour interval of 20 feet. The area surveyed consisted of 791 square miles, in connection with which 358 miles of levels were run, and 92 permanent bench marks were established.

Wyoming.—Mr. William H. Herron, topographer, on July 15 organized a party for the survey of the Devils Tower quadrangle, in Crook County, and continued in this vicinity until November 30, when 475 square miles had been mapped for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this quadrangle 174 miles of levels were run, and 42 permanent bench marks were established by Mr. Chester Irvine.

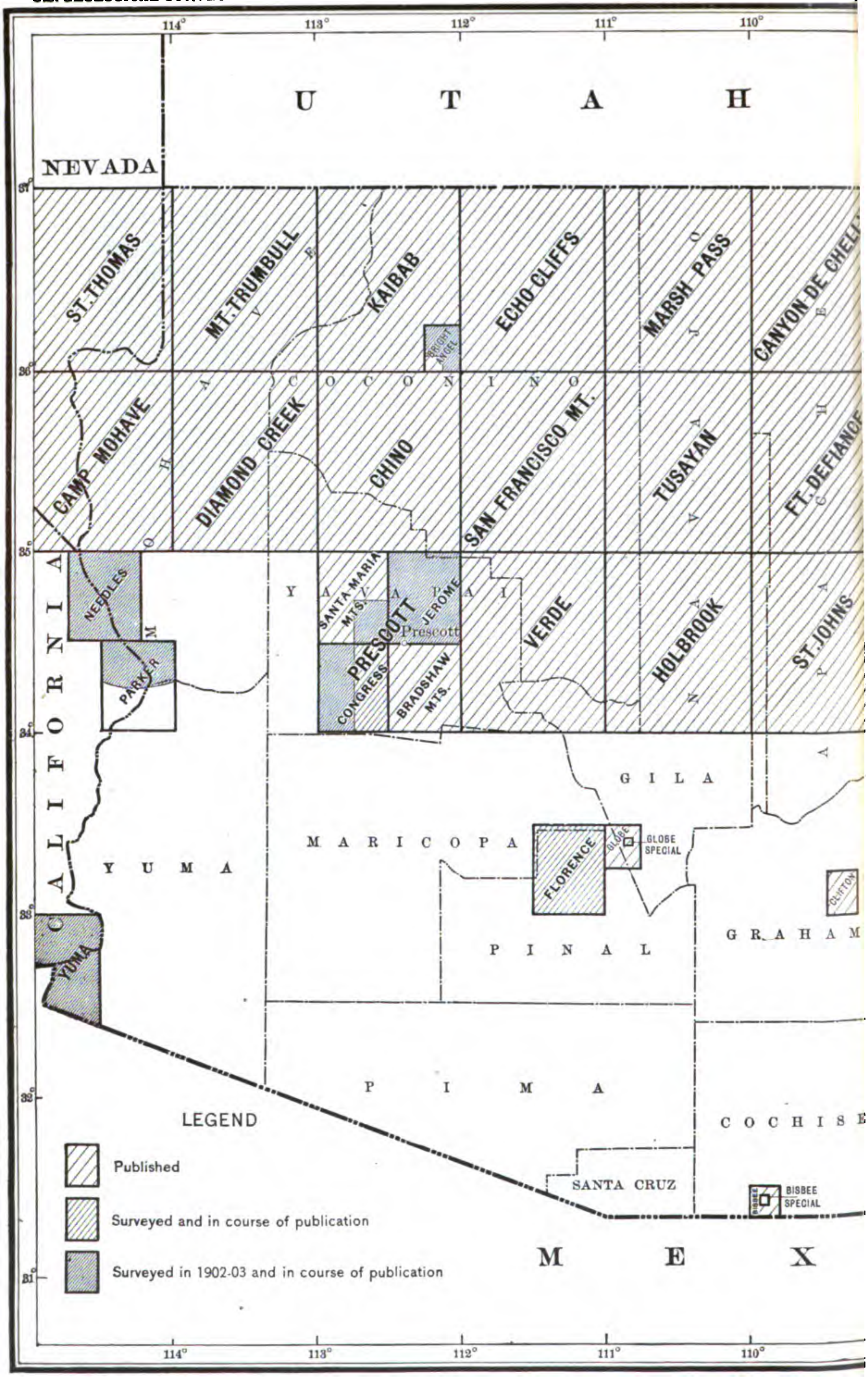
Colorado.—Mr. Frank Tweedy, topographer, during the season between July 9 and November 23 completed the survey of the Boulder and Niwot quadrangles, comprising an area of 457 square miles in Boulder County. This work was for publication on the scale of 1:62,500, with a contour interval of 100 feet for the Boulder and 20 feet for the Niwot quadrangle. For the vertical control of the 30-minute quadrangle including the above, Mr. F. M. Taylor ran 168 miles of levels, and established 55 permanent bench marks, in addition to leveling previously done

for the Niwot quadrangle. Mr. Richard T. Evans, assistant topographer, in September commenced the resurvey for the Cripple Creek Special map, in Teller County, and continued work as long as the weather permitted. A total of 26 square miles was resurveyed for publication on the scale of 1:25,000, with a contour interval of 50 feet. Mr. J. F. McBeth, topographer, during the season completed the survey of the Ouray quadrangle, covering an area of 150 square miles in Ouray, Hinsdale, and Gunnison counties, for publication on the scale of 1:62,500, with a contour interval of 100 feet.

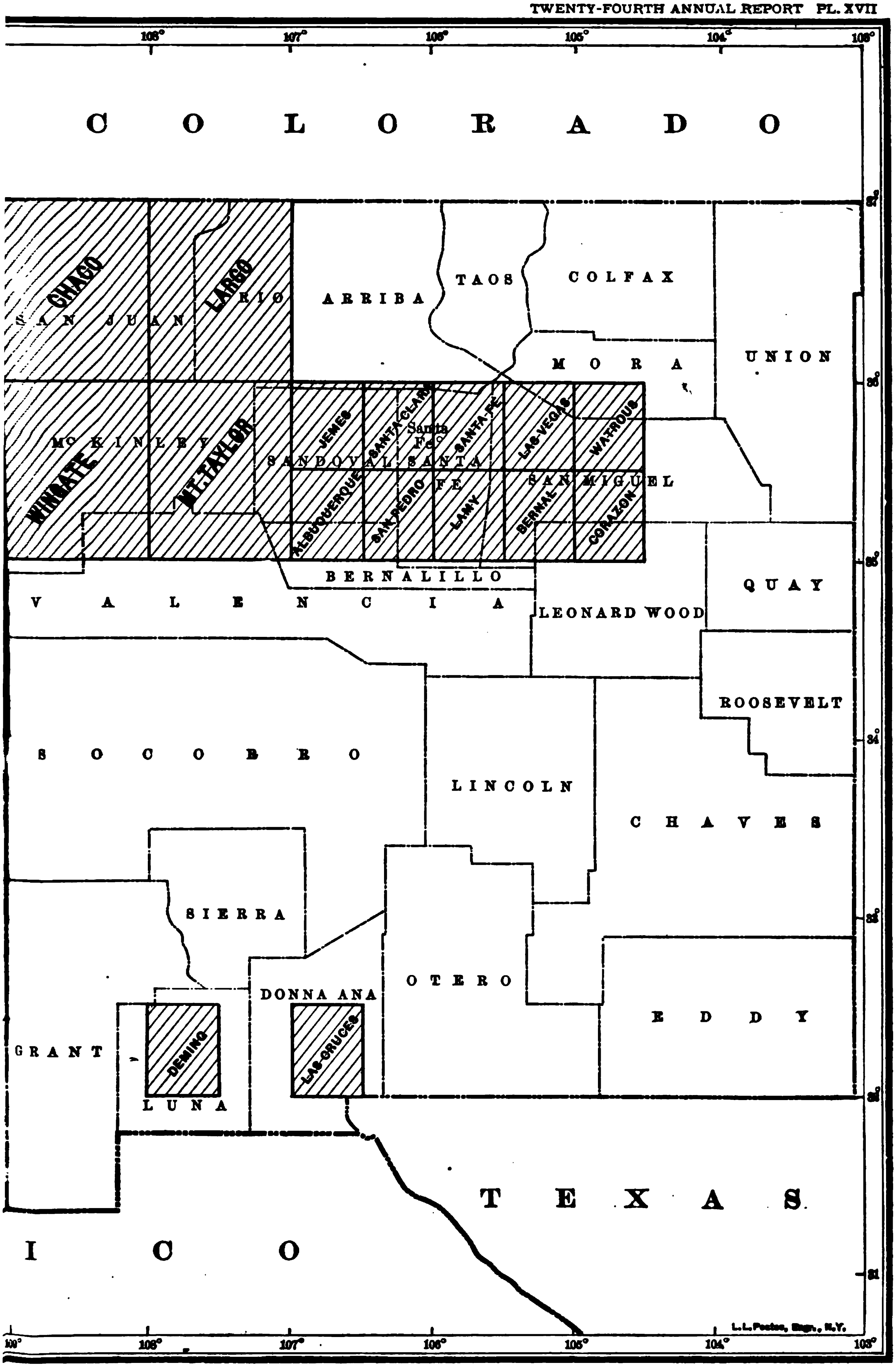
Utah.—Mr. Pearson Chapman, topographer, in July completed the field work for the Silver King Special map, in Summit County (Park City district), after which he was detailed to assist Mr. W. J. Lloyd, topographer, in the Uinta Forest Reserve survey. This work was for publication on the scale of 1:12,000, with a contour interval of 50 feet.

Arizona.—Mr. R. H. Sargent, topographer, assisted by Mr. H. H. Hodgeson, during the season completed the survey of the western part of the Congress quadrangle and the southeast quarter of the Santa Maria Mountain quadrangle, both in Yavapai County. The total area surveyed was 805 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Part of the expense of this survey was paid from the forestry appropriation, but the work is not elsewhere reported upon. The leveling for this area consisted of 185 miles of line, by Mr. John T. Stewart, in connection with which 58 permanent bench marks were established. In addition, check lines were run to Phœnix, thereby joining the Phœnix and Prescott datums. The latter consisted of 72 miles of levels, in connection with which 22 permanent bench marks were established.

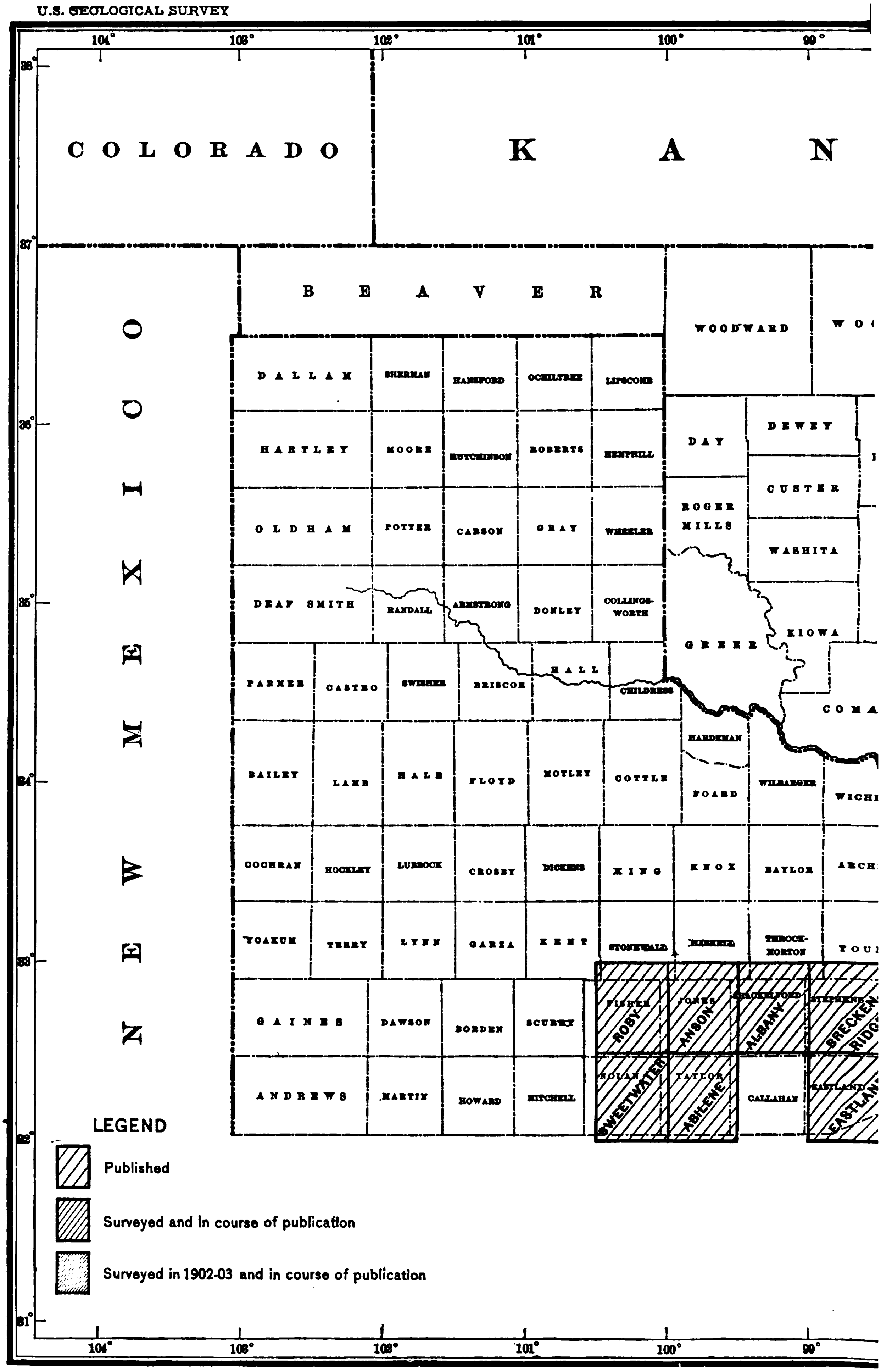
Indian Territory.—In May, 1903, Mr. Fred McLaughlin, field assistant, resurveyed 60 square miles of the Sansbois and Tuskahoma quadrangles, in the Choctaw Nation, for publication on the scale of 1:125,000, with a contour interval of 50 feet.



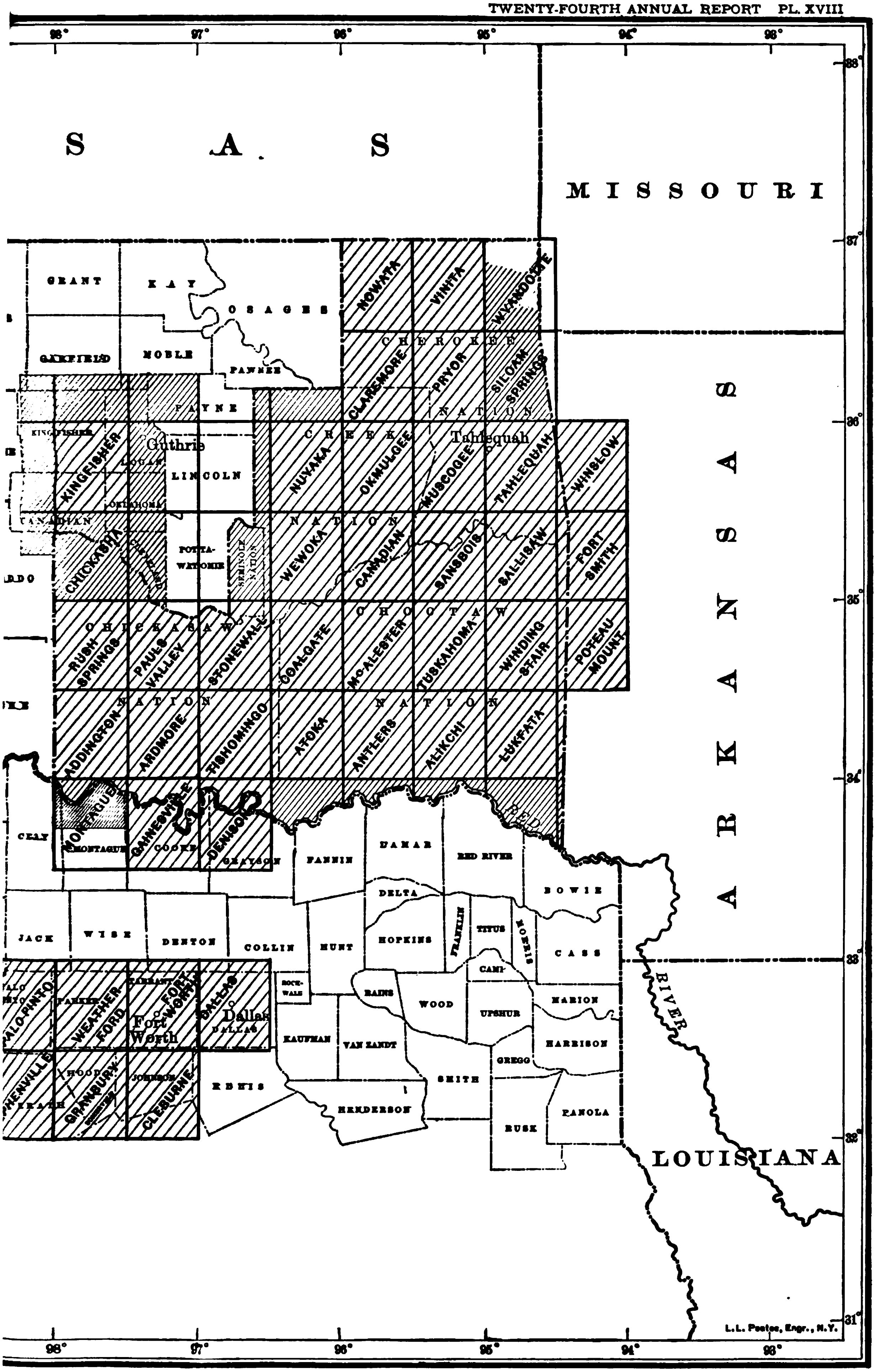
MAP OF ARIZONA AND NEW MEXICO, SHO



ING PROGRESS OF TOPOGRAPHIC SURVEYING.

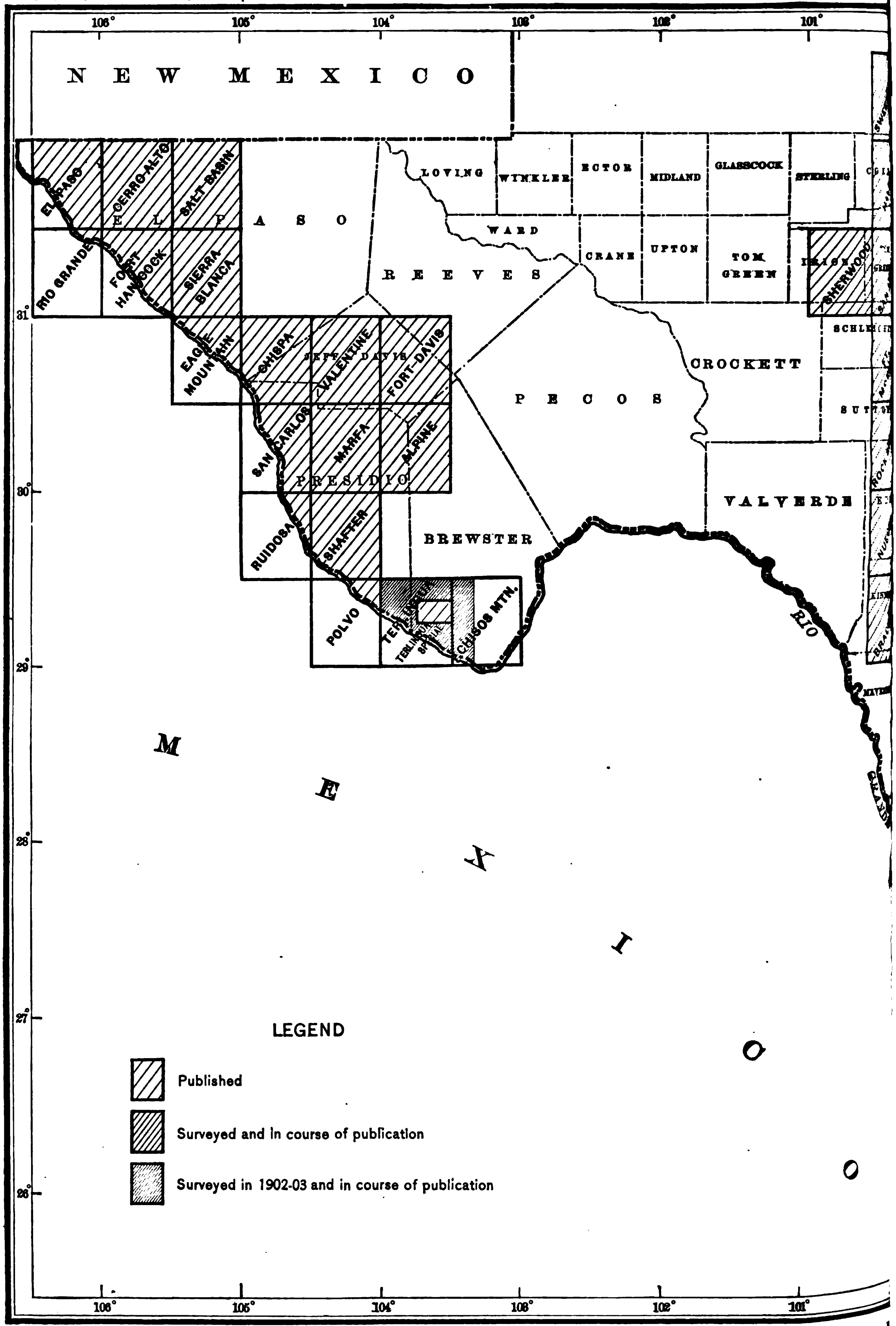


MAP OF INDIAN TERRITORY, OKLAHOMA, AND NORTHERN

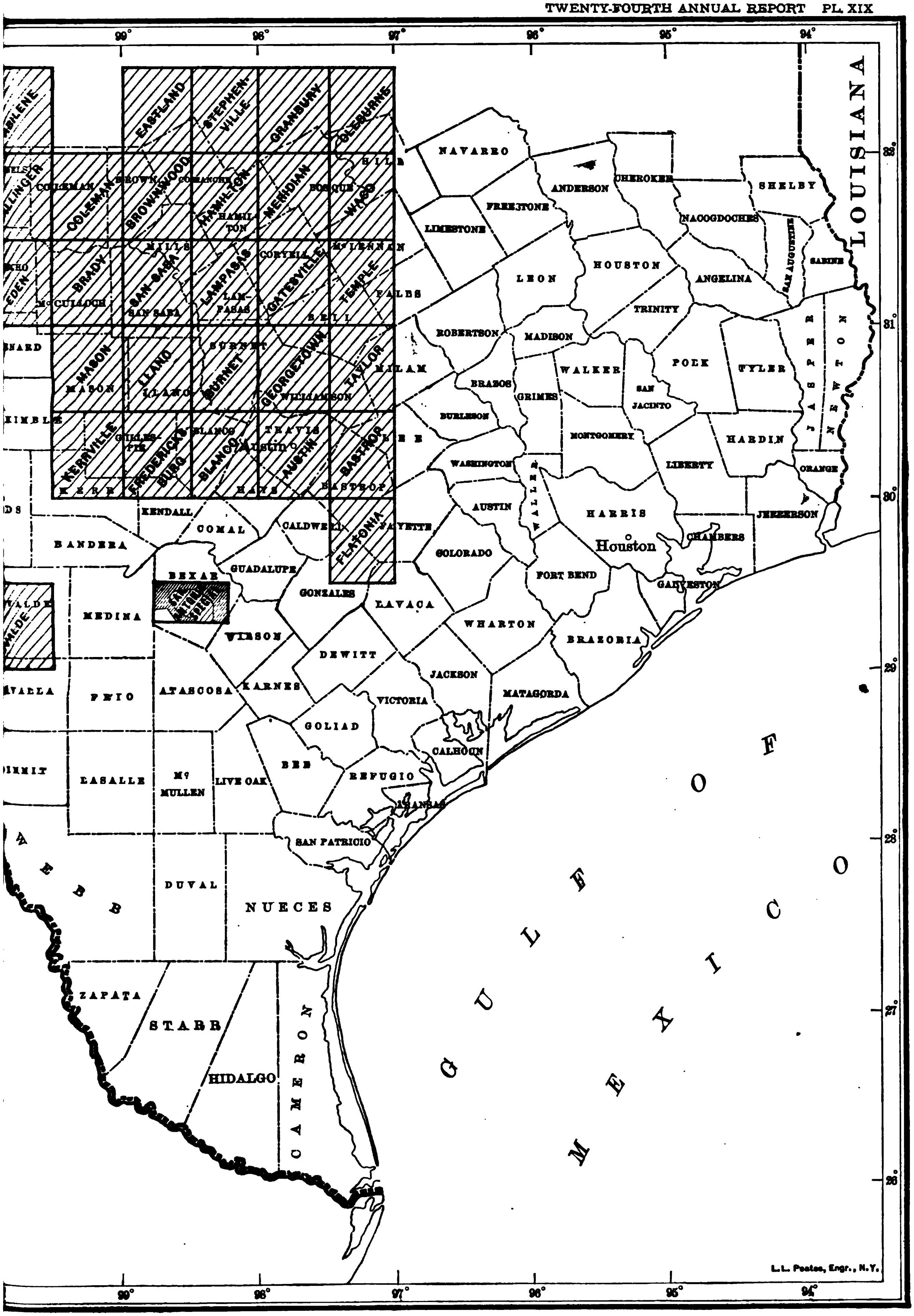


EXAS, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

U.S. GEOLOGICAL SURVEY



MAP OF SOUTHERN TEXAS, SHOWING



ROGRESS OF TOPOGRAPHIC SURVEYING.

Texas.—In cooperation with the University of Texas mineral survey, the United States Geological Survey completed the mapping of the Terlingua Special district, embracing an area of 65 square miles, in Brewster County, for publication on the scale of 1:50,000, with a contour interval of 25 feet. The engraving of the map was completed in November, and an edition of 4,000 copies was furnished the State survey at its expense. Mr. Arthur Stiles during the season also completed the survey of the Terlingua quadrangle, and began the mapping of the Chisos Mountain quadrangle, both comprising an area of 898 square miles in Brewster County, for publication on the scale 1:125,000, with a contour interval of 100 feet. In connection with this work 123 miles of levels were run and 34 permanent bench marks established by Mr. Chester Irvine, who also ran 138 miles, and established 42 permanent bench marks for the control of the Van Horn quadrangle. Mr. Fred McLaughlin, in December, commenced the survey of the Montague quadrangle in Clay and Montague counties, and continued work until June, 1903, when 335 square miles were completed for publication on the scale of 1:125,000, with a contour interval of 50 feet. In connection with this work Mr. M. S. Bright ran 106 miles of levels and established 22 permanent bench marks. Mr. J. F. McBeth, assisted by Mr. E. R. Bartlett, surveyed 193 square miles of the East San Antonio quadrangle, thereby completing the same, and also 160 square miles of the West San Antonio quadrangle, both in Bexar County. This work was for publication on the scale of 1:62,500, with a contour interval of 10 feet.

PACIFIC SECTION.

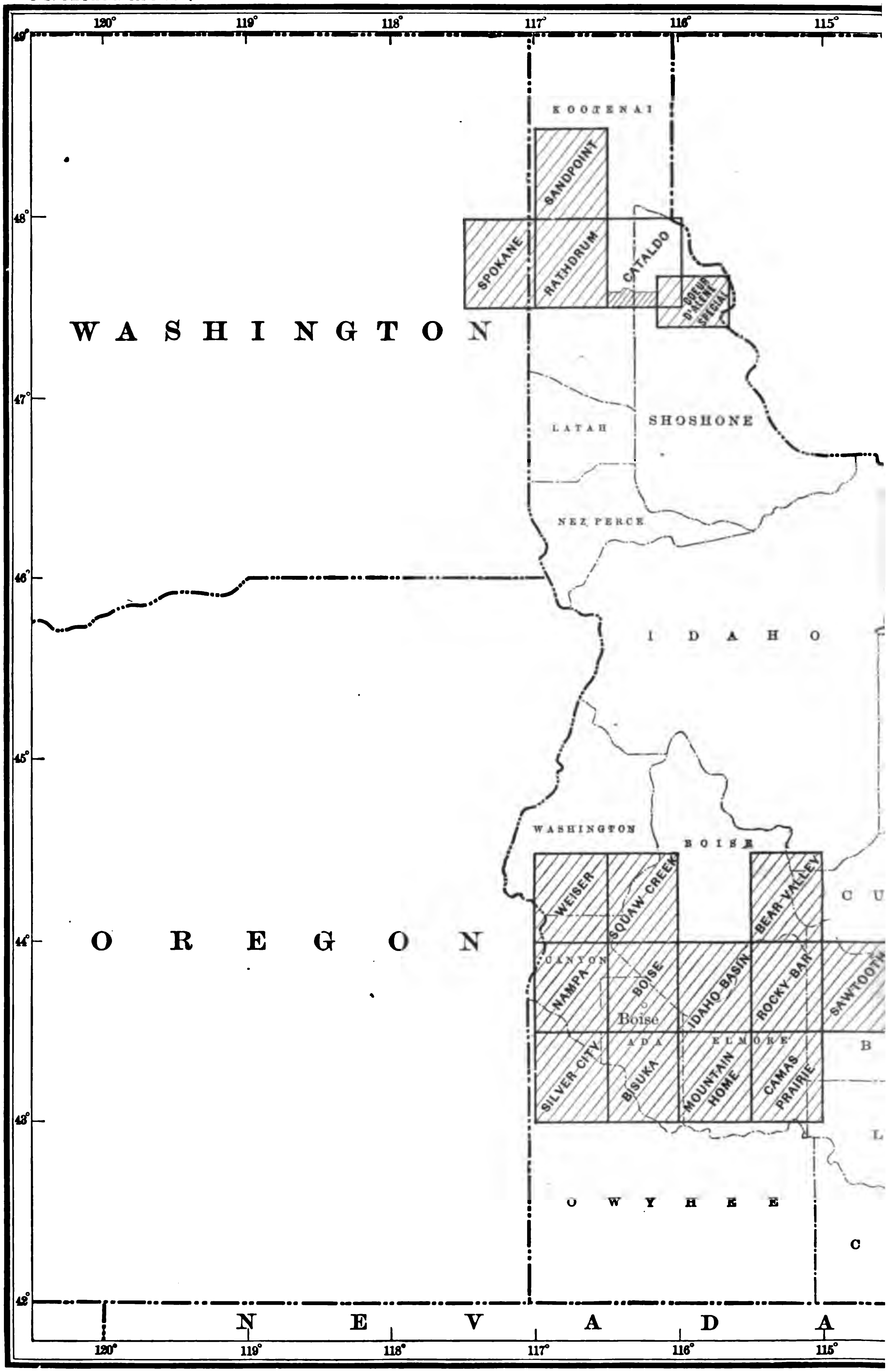
Topographic work was prosecuted by eight different parties in California, Nevada, Oregon, and Washington. The survey of six quadrangles was completed and two were partially surveyed. The total new area mapped was 3,843 square miles, of which 118 square miles were for publication on the scale of 1:62,500, 2,928 square miles were for publication on the scale of 1:125,000, and 797

square miles were for publication on special scales. In connection with the above, 1,847 linear miles of levels were run and 218 permanent bench marks were established.

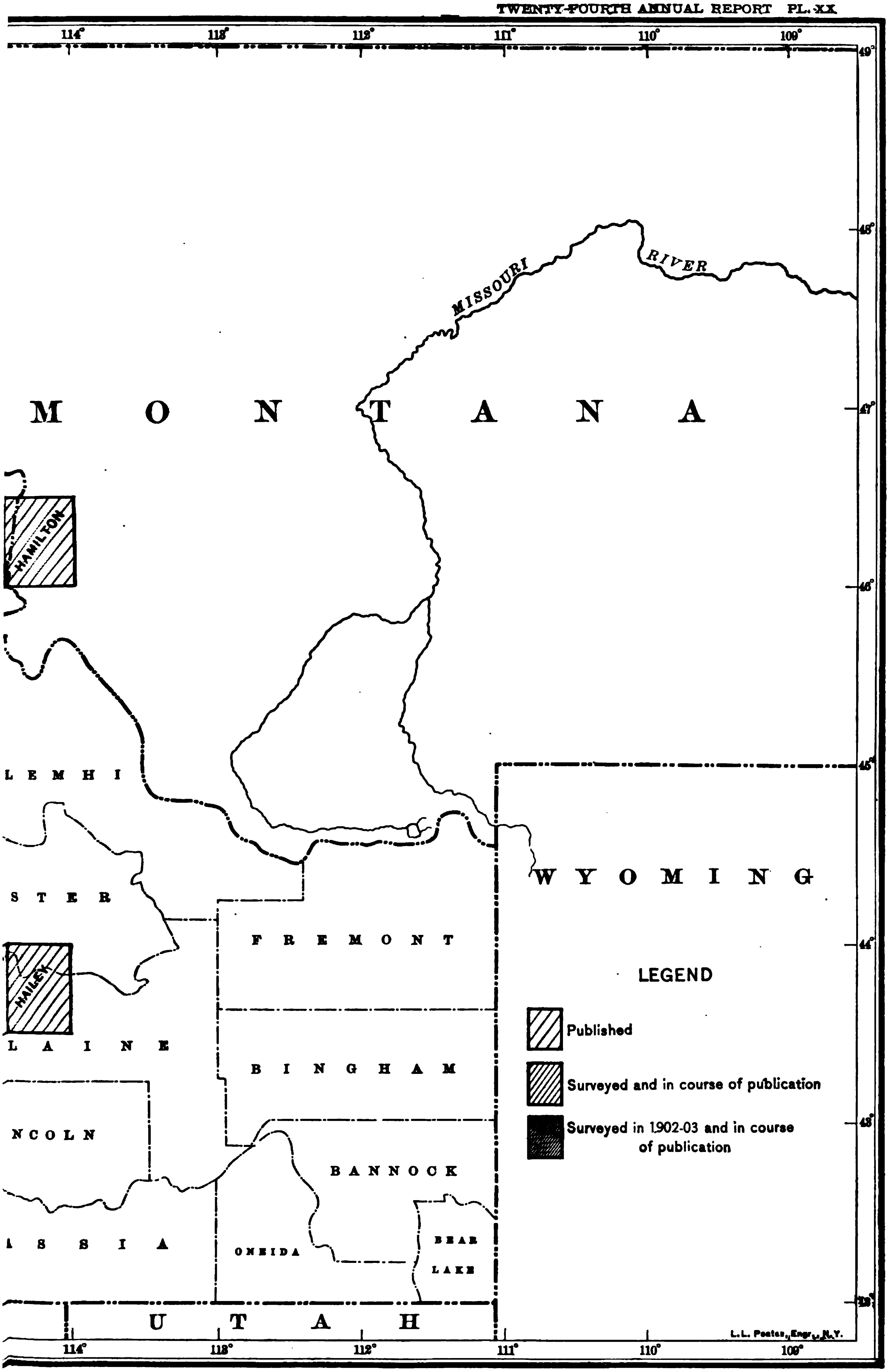
California.—Mr. John E. Rockhold, topographer, was assigned to the survey of the San Diego quadrangle, in San Diego County, and commenced work about July 1. He was thus engaged until October 12, when the quadrangle, embracing 118 square miles of land area, was completed for publication on the scale of 1:62,500, with a contour interval of 25 feet. Mr. Rockhold then commenced in the field the final drafting of the San Diego sheet, and completed the same on November 17, upon which date he was transferred to the hydrographic branch.

California-Arizona; Colorado River survey.—In cooperation with the reclamation division of the hydrographic branch, extensive topographic surveys were undertaken along the valley of the Colorado River and adjacent territory. The topographic mapping was done on two scales, one for publication on the scale of 2 inches to the mile, with a contour interval of 10 feet; and the other for publication on the scale of 1:125,000, or about 2 miles to the inch, with a contour interval of 50 feet.

The detailed work, or that on the larger scale, which was confined to the river valley, was inaugurated at two points—Needles, Cal., and Yuma, Ariz. Mr. E. C. Barnard, topographer, was in general charge at Needles from October 20 to January 17, when he was relieved by Mr. Hersey Munroe, who remained in the field until April 24. Three large parties for the detailed work were organized at Needles. Party No. 1 was at first under Mr. Barnard, who was succeeded by Mr. Munroe, who in turn was succeeded by Mr. J. G. Hefty, field assistant. With this party were Messrs. H. T. Paterson, assistant engineer, and J. S. Evans, field assistant, in charge of plane-table subparties. Party No. 2 was under Mr. A. P. Meade, jr., field assistant, with Messrs. R. B. Oliver and H. R. Ferris, field assistants, in charge of plane-table subparties. Party No. 3 was under Mr. A. I. Oliver, assistant topographer, who had as assistants in charge of plane-table

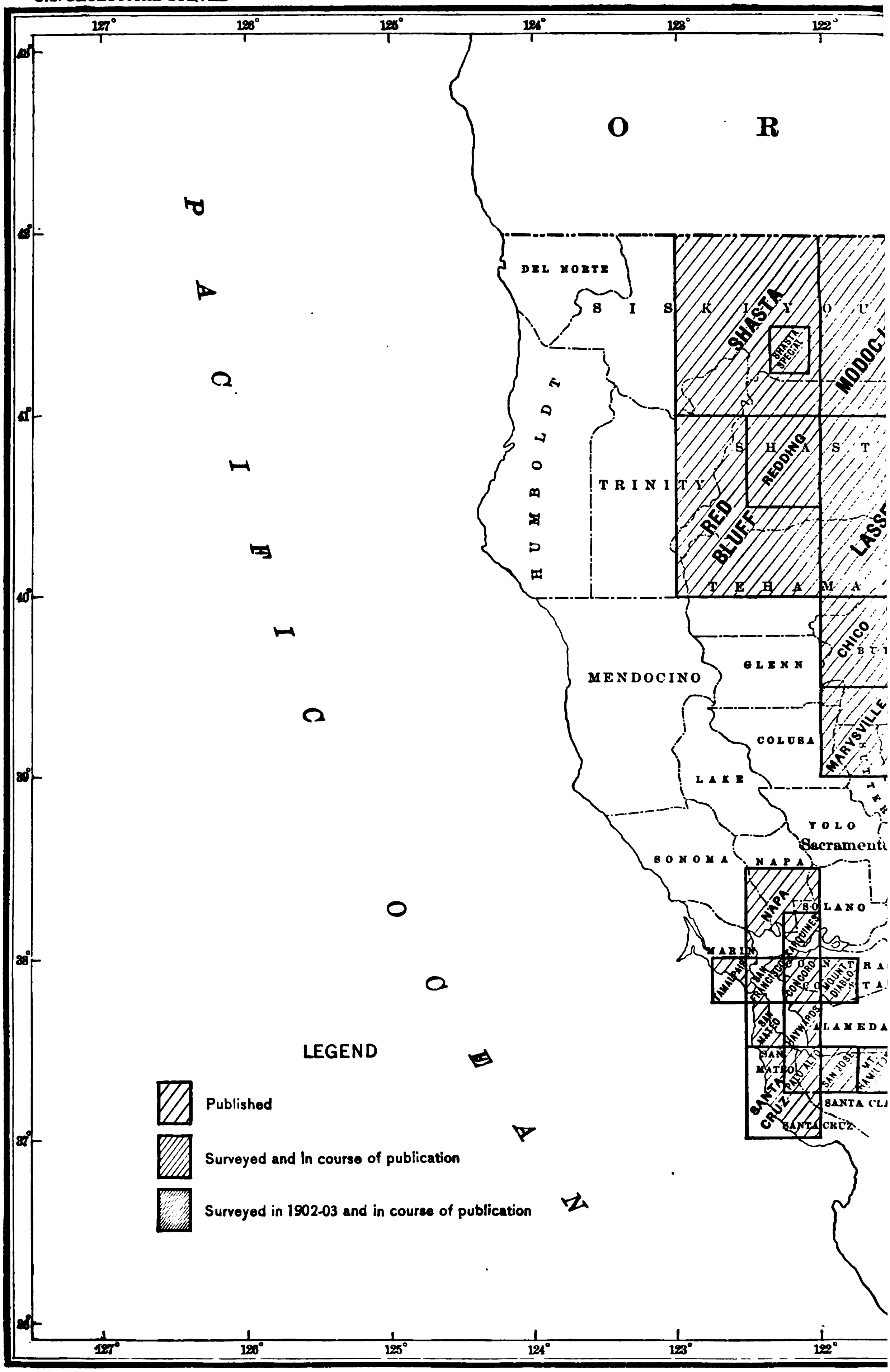


MAP OF IDAHO, SHOWING PROG

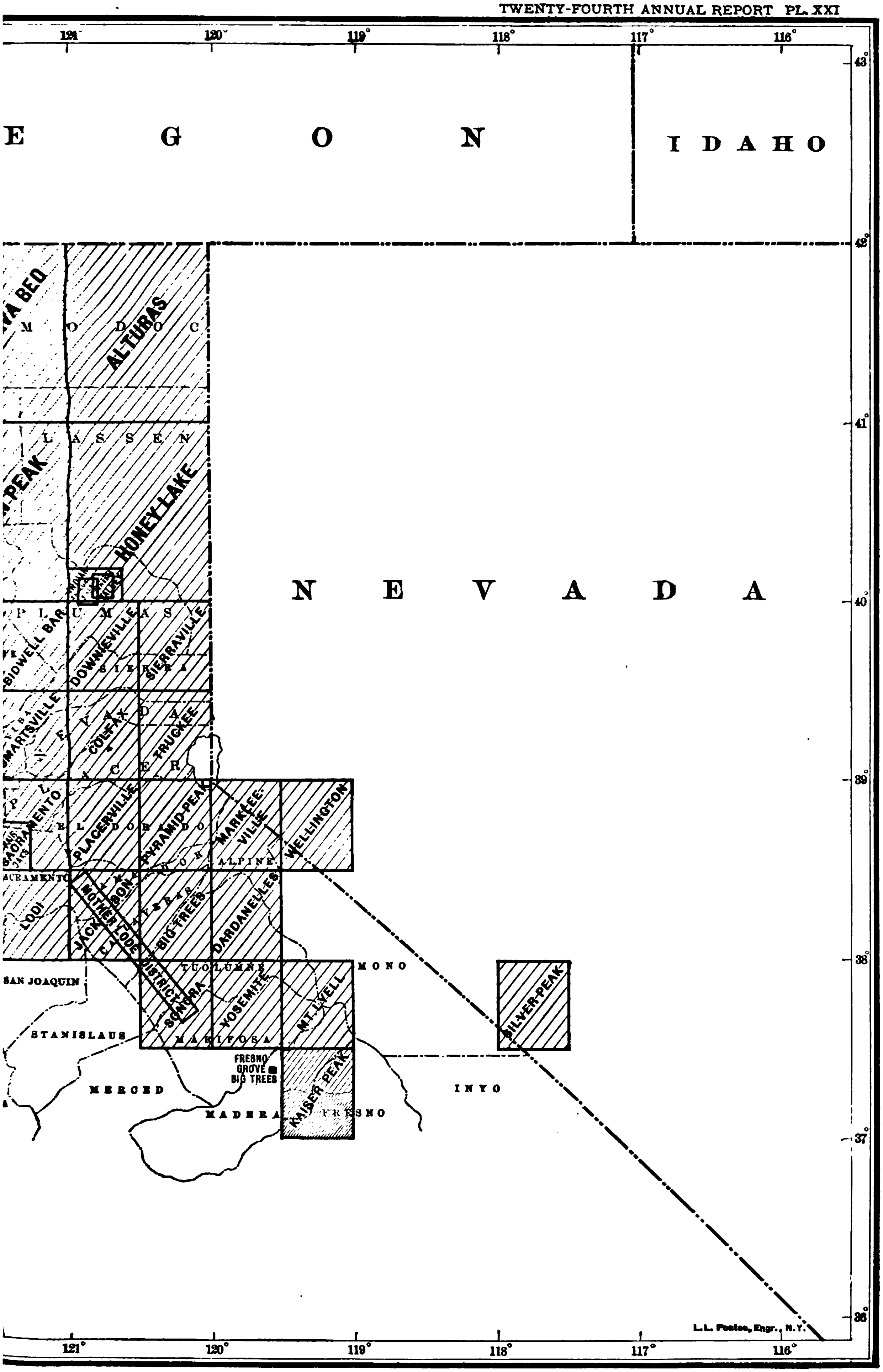


ESS OF TOPOGRAPHIC SURVEYING.

U.S. GEOLOGICAL SURVEY

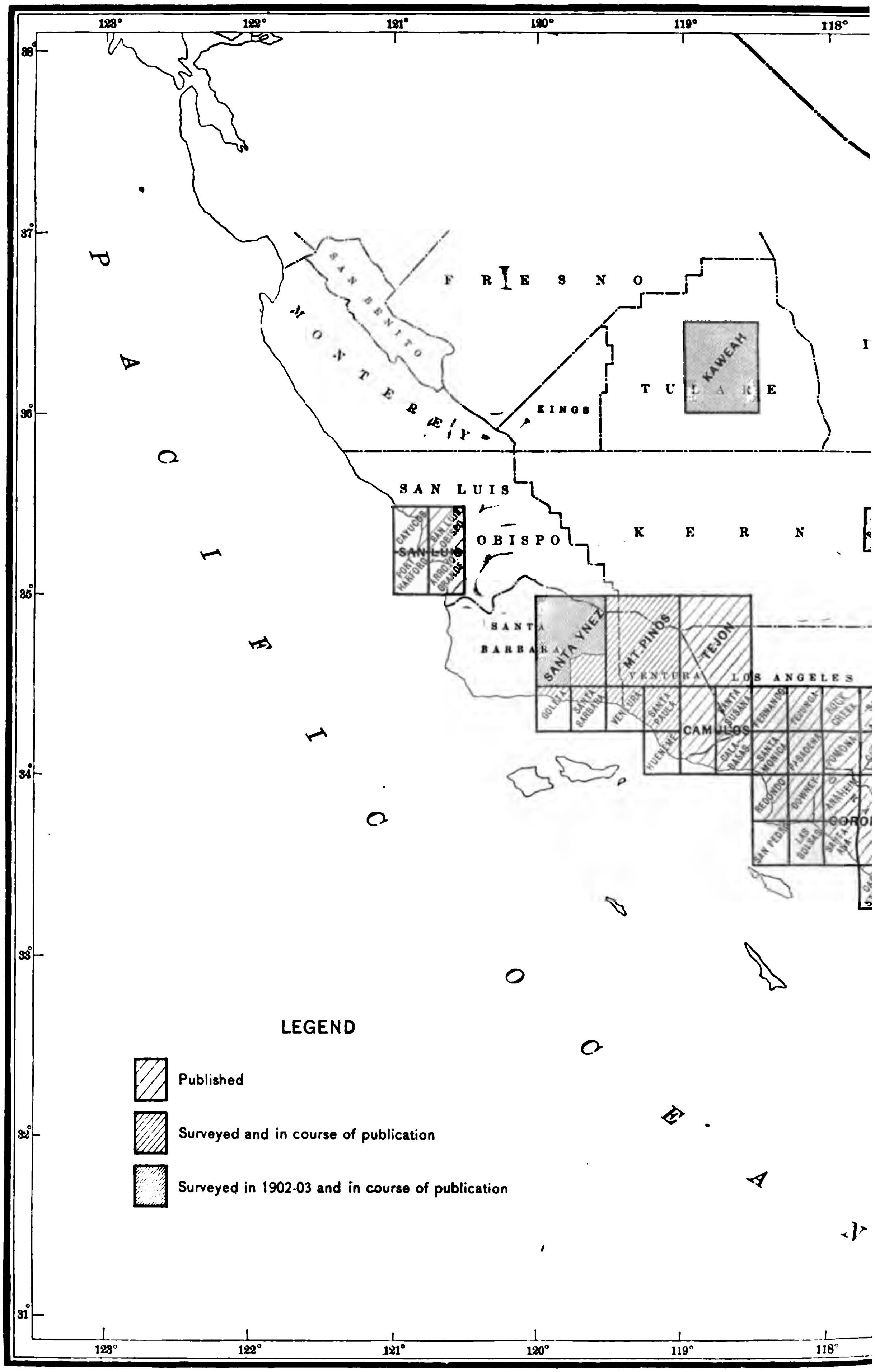


MAP OF NORTHERN CALIFORNIA, SHOWIN

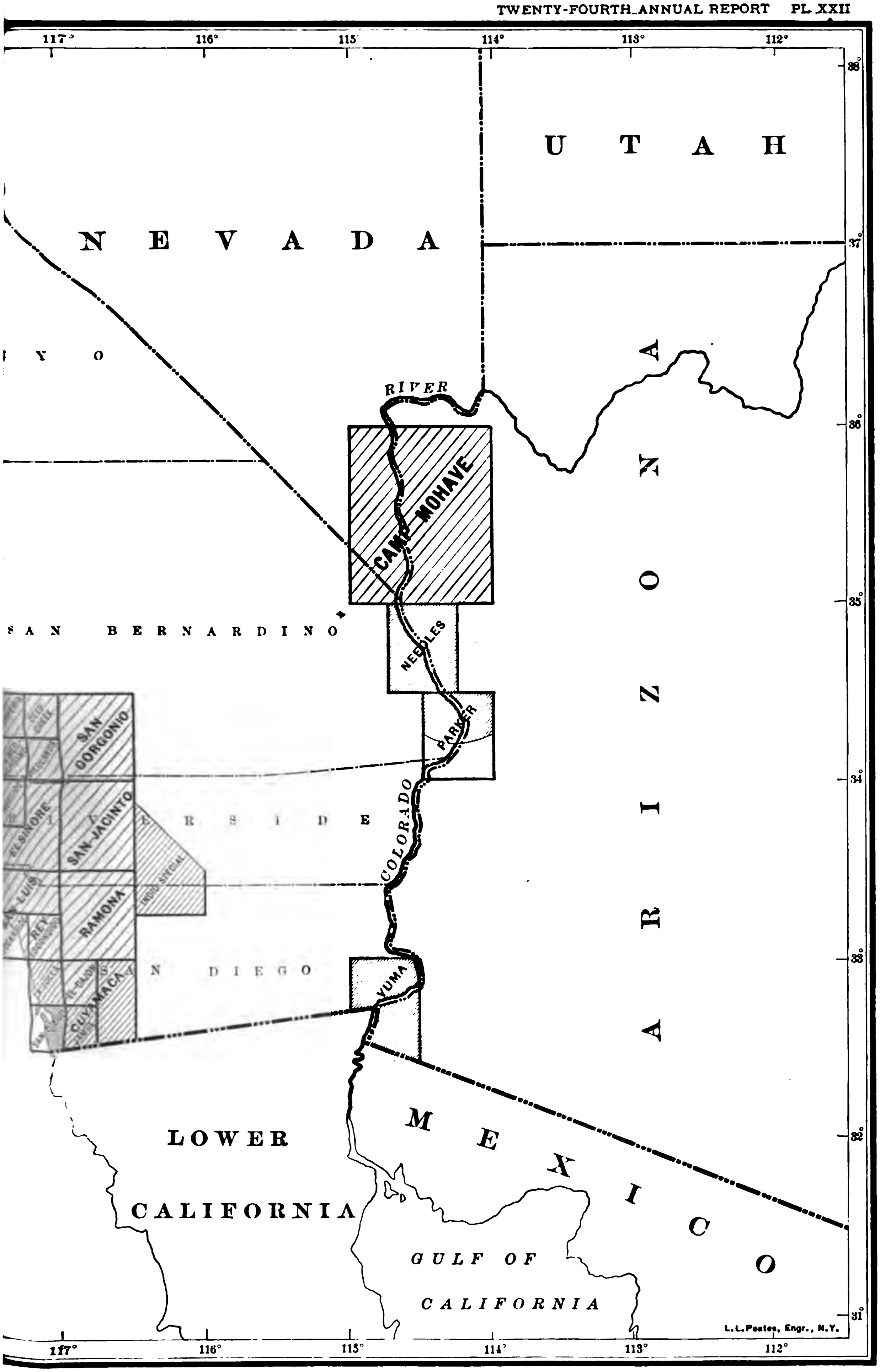


PROGRESS OF TOPOGRAPHIC SURVEYING.

U.S. GEOLOGICAL SURVEY



MAP OF SOUTHERN CALIFORNIA, SHOWING



ROGRESS OF TOPOGRAPHIC SURVEYING.

subparties Messrs. J. P. Gardner and F. S. Ryus, field assistants. Messrs. L. M. Lawson, J. T. Burke, J. N. Kerr, Goyne Drummond, M. D. Williams, and G. H. Hogue, assistant engineers, were also engaged on the detailed surveys at different times. These parties completed the mapping of the valley of the Colorado to an elevation of about 100 feet above the river bed, the area surveyed being 109 square miles within the Needles quadrangle, 178 square miles within the Parker quadrangle, and 54 square miles within the Ehrenberg quadrangle. The work on the Ehrenberg quadrangle was done partly under the supervision of the topographic branch by a party under Mr. R. B. Oliver, assisted by Messrs. Paterson and Burke, and partly under the supervision of the hydrographic branch.

Mr. R. B. Marshall, topographer, was in general charge of the detailed mapping in the vicinity of Yuma, Ariz. The work was commenced on November 7 and continued until the latter part of April, when the parties were disbanded. Two parties were organized. Mr. Marshall exercised supervision over party No. 1, having as assistants in charge of plane-table subparties Messrs. George R. Davis and B. B. Alexander, field assistants, and for a short time Messrs. J. P. Harrison and A. T. Fowler, field assistants. Mr. W. T. Turner, topographer, was in charge of party No. 2, with Messrs. S. N. Stoner and C. L. Nelson, field assistants, in charge of plane-table subparties. Mr. Turner remained in the field until February 10, when he proceeded to Washington, D. C., for office duty, leaving Mr. Stoner as chief of party. Upon Mr. Turner's departure Mr. Fowler was added to this party as an assistant in charge of a plane-table subparty. Messrs. C. M. Yeates and H. C. Hurd, assistant engineers, also served with these parties for a short period. The total output of the parties operating in the vicinity of Yuma on the detailed mapping was 449 square miles.

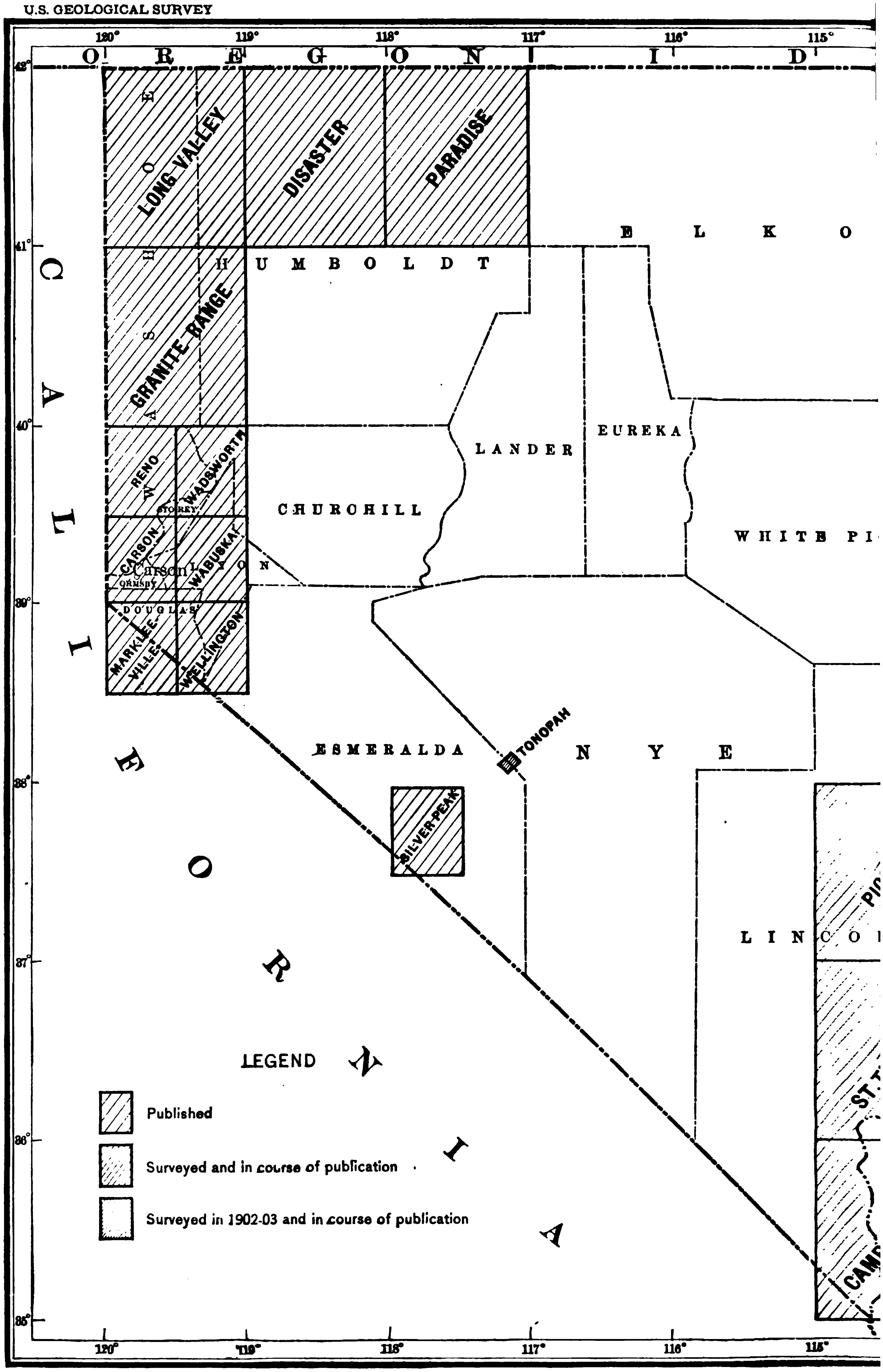
Two parties were organized at Needles for general mapping along the Colorado River, for publication on the scale of 1:125,000. This work supplemented the detailed

work, commencing where the latter stopped, and was extended into the adjacent foothills and mountains within the limits of the quadrangle under survey. One of these parties was under Mr. A. E. Murlin, topographer, and the other under Mr. C. W. Sutton, assistant topographer, both commencing work on October 21. Mr. Murlin remained in the field until December 12, when he proceeded to Washington, D. C., for office work. Mr. W. C. Guerin, field assistant, then assumed charge of the party and continued in the field until March 31. Mr. Sutton remained in the field in connection with the Colorado River work until April 30. The result of the work of these parties was the completion of the Needles quadrangle and about three-fourths of the Parker quadrangle. The area thus surveyed in the Needles quadrangle was 872 square miles, the remaining portion, amounting to 109 square miles, having been covered by the detailed river parties. The area surveyed in the Parker quadrangle was 355 square miles, 178 square miles in addition having been covered by the detailed work.

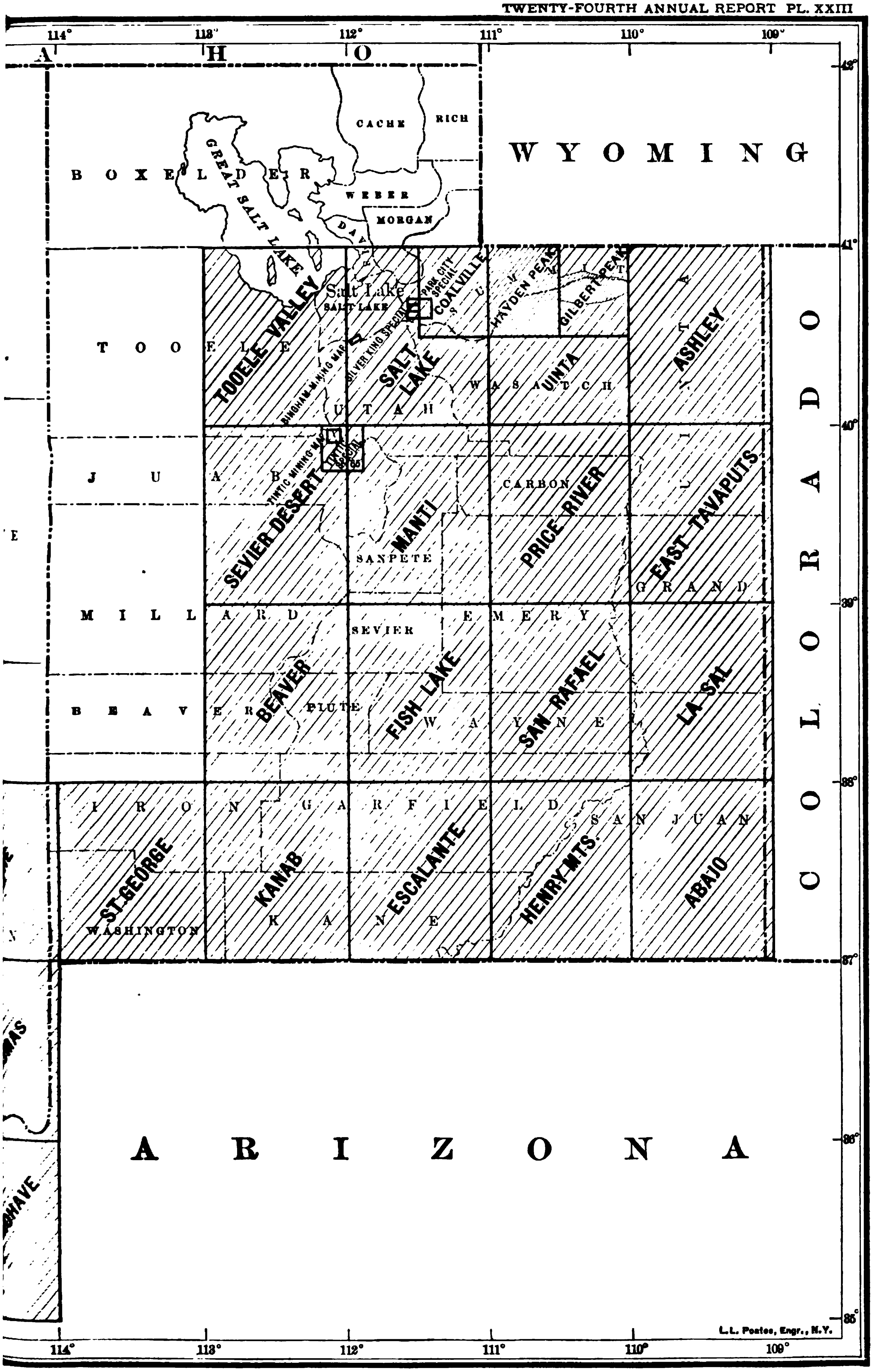
Mr. D. L. Reaburn, topographer, commenced work in the Yuma quadrangle on February 15 and completed the portion not covered by the detailed surveys on April 8, during which period an area of 480 square miles was mapped.

For the purpose of establishing a bench mark at Yuma, which should be based on a direct connection with mean sea level, Mr. R. A. Farmer, topographer, commenced leveling work at Colton, along the line of the Southern Pacific Company, on October 13. A portion of this line, namely from Colton to Montmere, had been previously leveled over, but it was rerun, a result closely corresponding to the original being obtained. From Montmere to Yuma the line was checked as it progressed by running forward a certain distance and then back over the same section. If there was a discrepancy of more than .05 of a foot between the two determinations the section was rerun a third time or more, until satisfactory results were obtained. At Yuma checks were obtained with the levels

U.S. GEOLOGICAL SURVEY



MAP OF NEVADA AND UTAH, SHOWING



PROGRESS OF TOPOGRAPHIC SURVEYING.

of the International Boundary, as well as those of the Southern Pacific Company, the Geological Survey elevations being 0.9 of a foot lower than those obtained from the Southern Pacific Company referred to the bridge seat of the bridge across the Colorado River and 0.8 of a foot lower than those obtained from a connection with monument No. 207 of the International Boundary line. Mr. Farmer was engaged on this work until January 6, 1903, and during this time ran 292 miles of levels and established 24 permanent bench marks. All of the leveling done along the Colorado River rested upon the bench mark established at Yuma, although that which was initiated at Needles was primarily based upon an assumed elevation taken from the profile of the Atchison, Topeka and Santa Fe Railroad. From Mellen, where the railroad crosses the Colorado River, Mr. E. W. Glafcke, levelman, ran a line down the west bank of the river, and Mr. Charles Hartmann, jr., levelman, carried a line down the east bank, the two lines being checked across the river at short intervals. Similarly, Messrs. L. D. Ryus and George L. Gordon, levelmen, proceeded up the river from Yuma on the west and east sides, respectively, until a junction was made with the parties working down the river. Thus a correction was obtained for reducing the Needles levels to a mean sea-level basis. Other levelmen engaged upon the work along the Colorado River were Messrs. S. E. Blout, H. A. Morrison, and C. J. Hoover. The total output along the Colorado River, in addition to the work done by Mr. Farmer, was 1,062 miles of levels, in connection with which 135 permanent bench marks were established.

Nevada.—Mr. W. J. Peters, topographer, upon his return from Alaska, was detailed to survey, on the scale of 1:96,000, or 800 feet to the inch, with a contour interval of 50 feet, a special area in the vicinity of Tonopah, Nev. Mr. Peters commenced this work, which was done in cooperation with the geologic branch, on November 24 and completed it on January 16, the area surveyed being 7 square miles in Esmeralda and Nye counties.

Oregon.—Operations were resumed by Mr. A. B. Searle,

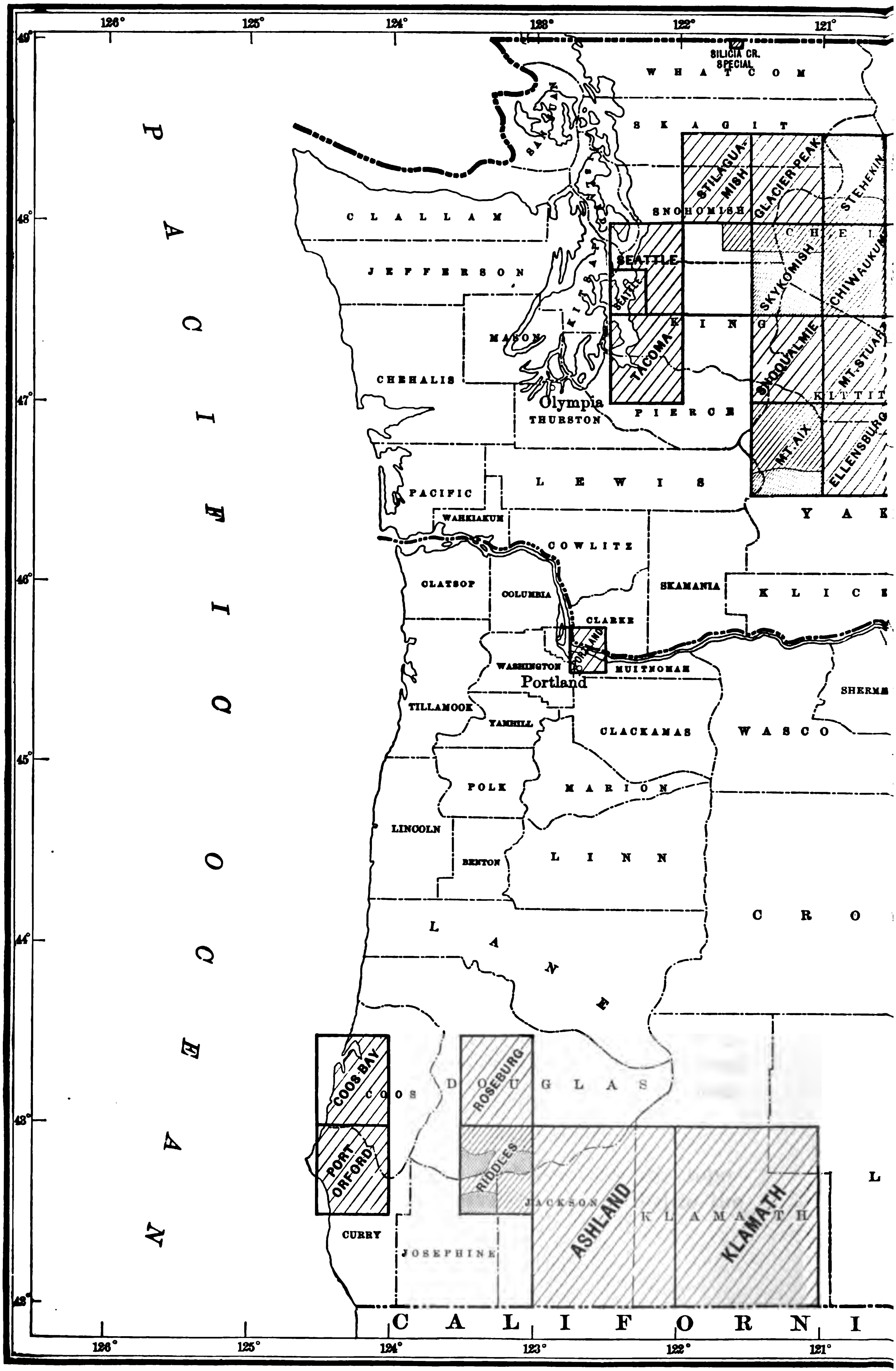
topographer, in the uncompleted portion of the Riddles quadrangle, commencing July 24 and continuing until January 26. The work was prosecuted under the same atmospheric and climatic conditions as prevailed during the previous year, dense smoke greatly retarding progress in the summer and heavy rains in the fall. An area of 278 square miles was mapped, including portions of Douglas, Josephine, and Jackson counties. This work was for publication on the scale of 1:125000, with a contour interval of 100 feet.

Washington.—Mr. L. C. Fletcher, topographer, with Mr. J. G. Hefty as principal assistant, was assigned to the survey of the Osooyos and Chapaca quadrangles, in Okanogan County, adjoining Canada on the north. The field work was begun on July 1 and continued until October 10. During this period the Osooyos quadrangle, containing 793 square miles, was completed and 150 square miles of the Chapaca quadrangle were mapped. This work was for publication on the scale of 1:125,000, with a contour interval of 100 feet. In connection with the above, 189 miles of levels were run, and 17 permanent bench marks were established by Mr. E. M. Fry, levelman. In addition, Mr. Fry reran 86 miles of levels to check work done in previous years.

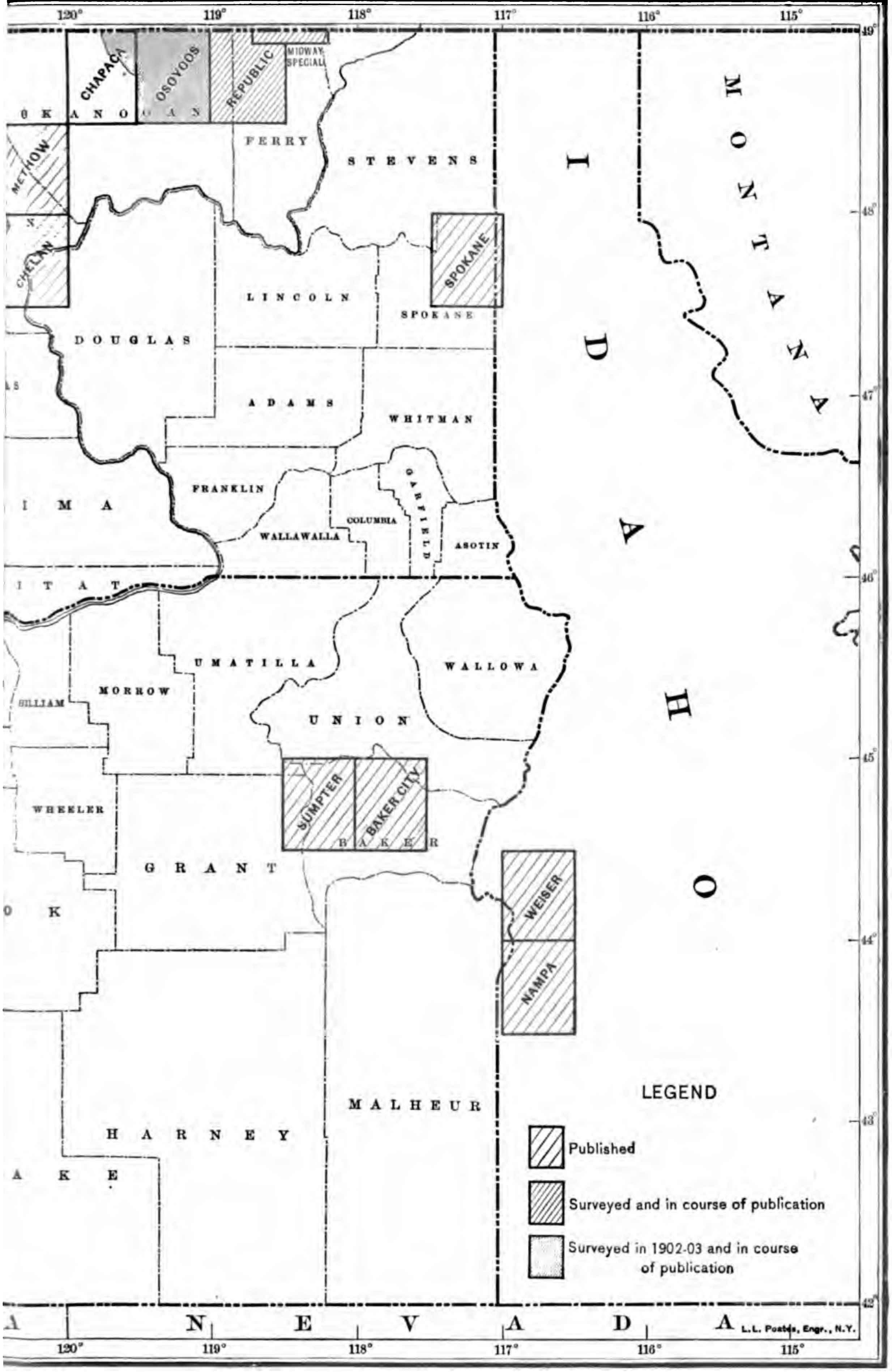
Leveling for the control of future mapping in California was done as follows: Mr. L. D. Ryus ran 23 miles in the vicinity of Fresno, in connection with which 3 permanent bench marks were established. Mr. Ryus also ran 46 miles of levels in the vicinity of Santa Rosa. Mr. W. V. Hardy, levelman, carried a line over the tracks of the Southern Pacific Company from Goshen Junction to Alcalde, a distance of 62 miles, in connection with which 16 permanent bench marks were established. Mr. S. E. Blout ran 87 miles of levels, and established 23 permanent bench marks for the control of the Pleasanton quadrangle.

SURVEYS OF FOREST RESERVES.

The organization continued as heretofore, the topographic surveys of certain reserves being assigned to the



MAP OF WASHINGTON AND OREGON, SHOWI



G PROGRESS OF TOPOGRAPHIC SURVEYING.

Rocky Mountain section, under Mr. Douglas, and the remaining reserves being assigned to the Pacific section, under Mr. Goode. Mr. Henry Gannett, geographer, was continued in charge of the forest examinations, but, being absent in the Philippines during most of the year, the necessary supervision of this work was exercised by Mr. F. H. Newell.

IN ROCKY MOUNTAIN SECTION.

Topographic surveys were conducted in the following reserves: Lewis and Clarke, Flathead, Crow Creek, Uinta, Prescott, and Grand Canyon, in addition to which level control was established for a number of quadrangles in the Santa Rita, Santa Catalina, and Gila River reserves. The survey and marking of the boundary line of the Bighorn Reserve was completed, also portions of the boundary lines of the Black Mesa and Mount Graham reserves. The mapping of three quadrangles was completed and four were partially mapped. The total new area surveyed was 2,735 square miles, of which 2,564 square miles were for publication on the scale of 1:125,000, and 171 square miles were for publication on the scale of 1:62,500. In connection with the above, 1,073 linear miles of levels were run and 362 permanent bench marks were established. In addition, 211 miles of boundary lines were surveyed and marked.

Montana; Lewis and Clarke Reserve.—Mr. T. M. Bannon, topographer, with Mr. William Stranahan, assistant topographer, on July 8 began the mapping of the Ovando quadrangle in Powell, Lewis and Clarke, and Missoula counties. The quadrangle was completed on October 29, the area mapped being 812 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet. The leveling for this quadrangle was done in previous years.

Montana; Flathead Reserve.—Mr. R. H. Sargent, topographer, on July 7 resumed field work in the Chief Mountain quadrangle and mapped 106 square miles, thus completing the same. He then commenced the survey of the Kintla Lakes quadrangle, continuing until October 11,

when he had completed 271 square miles. This work was all in Flathead County, and was surveyed for publication on the scale of 1: 125,000, with a contour interval of 100 feet.

Wyoming; Crow Creek Reserve.—Mr. M. S. Bright in September commenced work at an established bench mark near Fort Collins, Colo., and carried level lines northward over the greater portion of the Sherman quadrangle, in Albany and Laramie counties, tying the work to bench marks of the transcontinental line of the Coast and Geodetic Survey. The number of miles run was 130, in connection with which 48 permanent bench marks were established.

Wyoming; Bighorn Reserve.—Mr. W. H. Thorn, United States surveyor, early in July organized a party at Sheridan to complete the survey and marking of the Bighorn Forest Reserve boundary, 45 miles of which were then unmarked. This work was accomplished before September 1, and the entire boundary of the reserve is now marked with special iron posts. The plats and duplicate copies of the notes for the entire boundary survey have been completed and filed in the General Land Office, as required by law.

Utah; Uinta Reserve.—Messrs. W. J. Lloyd and Pearson Chapman, topographers, during the season from July 8 to October 20, completed the mapping of 390 square miles of the Gilbert Peak quadrangle, in Wasatch and Summit counties, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The leveling for this and adjoining quadrangles in the eastern part of the Uinta Reserve was executed by Mr. E. W. Glafcke, who during the season ran 123 miles of line and established 32 permanent bench marks.

Arizona; Prescott Reserve.—Mr. A. F. Dunnington, topographer, assisted by Messrs. F. E. Matthes, topographer, and Richard T. Evans, assistant topographer, in November organized a party for the survey of the Jerome quadrangle, in Yavapai County. Mr. Dunnington returned to Washington on January 1, leaving the

party in charge of Mr. Matthes, who in turn, on May 15, left it in charge of Mr. Evans. The quadrangle, comprising an area of 985 square miles, was completed in June, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Part of the expense of this work was paid from the appropriation for topographic surveys, but is not elsewhere reported upon.

Arizona; Grand Canyon Reserve.—In April Mr. Matthes commenced the survey of the Bright Angel quadrangle, in Coconino County, and continued in this vicinity until November, when 171 square miles were completed, for publication on the scale of 1: 62,500, with a contour interval of 50 feet. In March, 1903, Mr. John T. Stewart again took up the leveling for the Bright Angel, Bass, and Grand View quadrangles, and up to May 30, when the work was discontinued, had run 148 miles of levels, in connection with which 80 permanent bench marks were established.

Arizona; Santa Rita and Santa Catalina reserves.—Mr. M. S. Bright, in March, 1903, began leveling for the control of these reserves, and continued until May, when 260 miles of levels had been run and 70 permanent bench marks established.

Arizona; Black Mesa Reserve.—In September Mr. W. H. Thorn commenced the survey of the southern and eastern boundary lines of this reserve, and completed the same in April. Altogether 154 miles of line were surveyed and marked with 166 special iron posts. The preparation of the plats for this work and the copying of the notes are now in progress.

Arizona; Mount Graham Reserve.—In May, 1903, Mr. Thorn was detailed to survey and mark 12 miles of the eastern boundary of this reserve, which had not been previously surveyed, under the direction of the General Land Office. This work was completed May 31, and in connection with it 4 iron boundary posts were set.

New Mexico; Gila River Reserve.—At the time the last annual report was prepared leveling for the control of the Graham quadrangle, in Grant and Socorro counties, was in progress by Mr. Chester Irvine. This work was

discontinued in June, but was resumed in December; 412 miles of levels were run and 132 permanent bench marks were established.

Retracement work.—In the survey of the boundary lines of forest reserves above referred to, the retracement of many miles of line was necessary, but this work is not included in the present report.

IN PACIFIC SECTION.

Topographic work was prosecuted in the following reserves: Pine Mountain and Zaca Lake, Sierra, Mount Rainier, and Washington. The total new area mapped was 3,749 square miles, all of which was for publication on the scale of 1:125,000. The above includes the complete mapping of seven quadrangles, in connection with which 1,033 linear miles of levels were run and 296 permanent bench marks were established.

California; Pine Mountain and Zaca Lake Reserve.—Mr. W. T. Turner, topographer, with Mr. S. N. Stoner, field assistant, was assigned to the survey of the Santa Ynez quadrangle, in Santa Barbara and San Luis Obispo counties, commencing work on July 6. A portion of this quadrangle had been surveyed during the previous season, and it was entirely completed at the end of October, the area surveyed being 708 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Upon the completion of this work Messrs. Turner and Stoner proceeded with the camp outfit to Yuma, Ariz., for work in that vicinity in connection with the reclamation service.

Mr. E. C. Barnard, topographer, was assigned to the charge of a party detailed to survey the Kaweah quadrangle, in Tulare County, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The party was organized on July 11 and Mr. Barnard remained with it until October 16, when he proceeded to Needles, Cal., to take charge of work in cooperation with the reclamation service at that point. The topographic mapping was continued, however, under the direction of Mr. A. I.

Oliver, assistant topographer, until December 1, when the quadrangle, embracing an area of 960 square miles, was completed. Messrs. R. B. Oliver and W. C. Guerin, field assistants, were also engaged upon this quadrangle, the former throughout the season and the latter from October 16. Mr. E. T. Perkins, topographer, also assisted on this quadrangle in a general way through the month of July, after which he was transferred to the reclamation service. In connection with the above, 182 miles of levels were run and 35 permanent bench marks were established by Mr. W. V. Hardy, levelman.

Mr. R. B. Marshall, topographer, with Mr. George R. Davis as principal assistant, resumed the survey of the Kaiser quadrangle, in Madera and Fresno counties, on July 6 and completed it on October 27, mapping 527 square miles. This work was for publication on the scale of 1:125,000, with a contour interval of 100 feet. After the completion of this survey Mr. Marshall proceeded with this outfit to Yuma, Ariz., and assumed general charge of work in cooperation with the reclamation service in that vicinity.

For the control of the Mount Silliman quadrangle Mr. Ryus ran 55 miles of levels and established 6 permanent bench marks.

Washington; Mount Rainier Reserve.—Mr. A. H. Sylvester, topographer, resumed work on the Mount Aix quadrangle, commencing July 7 and continuing until October 23. During this period an area of 281 square miles in Lewis and Yakima counties was mapped, thus completing the quadrangle. This mapping was done for publication on the scale of 1:125,000, with a contour interval of 100 feet. After the close of the field season in Washington, Mr. Sylvester was assigned to duty in southern California.

Washington; Washington Reserve.—Mr. R. A. Farmer, topographer, was detailed to complete the survey of the Stehekin quadrangle, in Chelan, Snohomish, and Okanogan counties, commencing work on July 1 and continuing

until October 8, when the quadrangle was completed, the area surveyed being 560 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. Upon the completion of this work, in which he was assisted by Mr. C. E. Hill, field assistant, Mr. Farmer proceeded to southern California for duty in cooperation with the reclamation service.

A party under the direction of Mr. A. E. Murlin, topographer, commenced work on the Skykomish quadrangle, in Kittitas, King, Snohomish, and Chelan counties, on July 8 and remained in the field until September 30. Mr. Murlin was assisted by Mr. C. W. Sutton, assistant topographer, and Mr. W. C. Guerin, field assistant. A portion of this quadrangle had been previously surveyed in 1898 by Mr. T. G. Gerdine, topographer, and the remaining portion, amounting to 713 square miles, was completed in the interval given above, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Upon the completion of this work Mr. Murlin and his party proceeded to southern California for other duty.

California-Oregon.—For the primary vertical control of the topographic work in the forest reserves in California and Oregon, Mr. C. H. Semper, levelman, resumed work about July 1 on the line commenced by him during the preceding season, and in August completed the check between a tidal connection at Benicia on San Francisco Bay and San Pedro on San Pedro Bay. The portion of the line previously run between San Pedro and Fernando was accepted, and in a total distance of 528 miles between Benicia and San Pedro the closure error was 0.243 foot.

Mr. Semper then took up the level work at Davis, a point on the old line, and extended it northward along the tracks of the Southern Pacific Company to Portland, Oreg., reaching the latter point on May 27. Here connection was made with a line previously brought from Astoria, at the mouth of the Columbia River. The distance between Astoria and Benicia is 857 miles and the closure error at Portland was 0.419 foot. The distance run by Mr. Semper during the field season extending

through eleven months was 796 miles, in connection with which 255 permanent bench marks were established.

OFFICE WORK IN TOPOGRAPHIC MAPPING.

The work of surveying was discontinued by the various parties from time to time between November and February, and the party chiefs reported for office work in Washington. In the Atlantic section this was organized by Mr. H. M. Wilson, geographer in charge, into the following subsections: New York, in charge of Mr. J. H. Jennings; Pennsylvania, in charge of Mr. Frank Sutton; Maryland and North Carolina, in charge of Mr. W. Carvel Hall; West Virginia, in charge of Mr. A. M. Walker; and Southern and New England States in charge of Mr. R. D. Cummin. The chiefs of these various subsections had entire supervision of all drafting done in the various areas constituting the Atlantic section, and proof-read all manuscript maps as well as printed proof received from the engraving division. In the other sections no organization of office work other than immediate supervision by the section chiefs was attempted except for Alaska, where the drafting of the maps resulting from the surveys in Alaska and of the international boundary between the United States and British Columbia was placed under the general supervision of Mr. E. C. Barnard.

In January the committee on base maps recommended that the preparation of all large-scale topographic base maps containing sufficient detail to show roads and contours, as distinguished from outline base maps, be placed under the topographic committee. In accordance with this recommendation, Mr. A. C. Roberts was placed in temporary charge of the preparation of such maps, Mr. Vladimir Sournin was appointed as topographic draftsman to assist him, and Mr. C. A. Clunet, field assistant, was temporarily assigned to the same work. Under Mr. Roberts's direction the entire revision and redrafting of the large topographic wall map of the United States was commenced, a work which involved the inking of 100,

500, or 1,000 foot contours on the entire issue of topographic sheets, as well as their reduction to the scale of the wall map and their adjustment thereon.

The section chiefs were assisted in office management by the following stenographers and clerks: Miss Mary H. Corbett, Miss Helen Fields, and Miss Mary Mitchell, who, in addition to attending to correspondence, were engaged in the tabulation of the reports, cataloguing of maps, and other clerical duties connected with the recording of progress in the topographic branch.

During the office season the drafting of 97 atlas sheets was completed. These were distributed as follows: Atlantic section, 52; Central section, 19; Rocky Mountain section, 14; Pacific section, 12. The following table, arranged alphabetically by States, enumerates these in detail:

Topographic sheets completed in office during 1902-3.

State and sheet.	Scale.	Contour interval.
Arizona:		Feet.
Congress	1:125,000	100
California:		
Kaiser	1:125,000	100
Kaweah	1:125,000	100
San Diego	1:62,500	25
Santa Ynez	1:125,000	100
Southern California No. 2	1:250,000	250
California-Arizona:		
Needles	1:125,000	50
Colorado:		
Boulder	1:62,500	100
Niwot	1:62,500	20
Ouray	1:62,500	100
Illinois:		
Peoria	1:62,500	10
Illinois-Indiana:		
Mount Carmel	1:62,500	20
Kansas:		
Iola	1:125,000	20
Maine:		
Anson	1:62,500	20
Cherryfield	1:62,500	20

Topographic sheets completed in office during 1902-3—Continued.

State and sheet.	Scale.	Contour interval.
MARYLAND:		*Feet.*
Annapolis	1:62,500	20
Baltimore	1:62,500	20
Nanticoke	1:62,500	20
North Point	1:62,500	20
Oxford	1:62,500	20
Sharps Island	1:62,500	20
St. Michaels	1:62,500	20
MICHIGAN:		
Ann Arbor	1:125,000	20
MISSOURI:		
Gravois Mills	1:62,500	20
Eldon	1:62,500	20
MONTANA:		
Fort Assinniboine	1:62,500	20
Chinook	1:62,500	20
Havre	1:62,500	20
Chief Mountain	1:125,000	100
Ovando	1:125,000	100
Yantic	1:62,500	20
NEBRASKA:		
Weeping Water	1:125,000	20
NEVADA:		
Tonopah	1:96,000	50
NEW YORK:		
Batavia	1:62,500	20
Boonville	1:62,500	20
Caledonia	1:62,500	20
Carthage	1:62,500	20
Chautauqua	1:62,500	20
Copake	1:62,500	20
Coventry	1:62,500	20
Fire Island	1:62,500	20
Greene	1:62,500	20
Hobart	1:62,500	20
Long Lake	1:62,500	20
Richmondville	1:62,500	20
Saranac Lake	1:62,500	20
Setauket	1:62,500	20
Wayland	1:62,500	20

Topographic sheets completed in office during 1902–3—Continued.

State and sheet.	Scale.	Contour interval.
NORTH CAROLINA:		*Feet.*
Ayden	1:62,500	10
Edenton	1:62,500	10
Falkland	1:62,500	10
Kenly	1:62,500	20
Rocky Mount	1:62,500	10
Springhope	1:62,500	20
Tarboro	1:62,500	10
Vanceboro	1:62,500	10
Wilson	1:26,500	10
NORTH DAKOTA-MINNESOTA:		
Wahpeton	1:125,000	20
OHIO:		
Berea	1:62,500	10
Macksburg	1:62,500	20
St. Clairsville	1:62,500	20
Salineville	1:62,500	20
Scio	1:62,500	20
Westerville	1:62,500	10
Woodsfield	1:62,500	20
OHIO-WEST VIRGINIA:		
Clarington	1:62,500	20
New Matamoras	1:62,500	20
Steubenville	1:62,500	20
Wellsville	1:62,500	20
OREGON:		
Riddles	1:125,000	100
PENNSYLVANIA:		
Amity	1:62,500	20
Barnesboro	1:62,500	20
Curwensville	1:62,500	20
Ebensburg	1:62,500	20
Eldersridge	1:62,500	20
Lancaster	1:62,500	20
Newcastle	1:62,500	20
Patten	1:62,500	20
SOUTH CAROLINA:		
Columbia	1:125,000	20
TENNESSEE-NORTH CAROLINA:		
Roan Mountain	1:125,000	100

Topographic sheets completed in office during 1902–3—Continued.

State and sheet.	Scale.	Contour interval.
TEXAS:		*Feet.*
East San Antonio	1:62,500	10
Terlingua	1:125,000	100
Terlingua Special	1:50,000	25
VERMONT:		
Brandon	1:62,500	20
WASHINGTON:		
Mount Aix	1:125,000	100
Osooyos	1:125,000	100
Skykomish	1:125,000	100
Stehekin	1:125,000	50
WEST VIRGINIA:		
Blacksville	1:62,500	20
Bruceton Mills	1:62,500	20
Cameron	1:62,500	20
Philippi	1:62,500	20
Vadis	1:62,500	20
Weston	1:62,500	20
WEST VIRGINIA–OHIO:		
Marietta	1:62,500	20
Parkersburg	1:62,500	20
ALASKA:		
Juneau	1:62,500	100

TRIANGULATION AND COMPUTING SECTION.

FIELD WORK.

IN ATLANTIC SECTION.

Primary control and traverse work was carried on at various times during the season by six parties. It was distributed over portions of eight States—Maine, New Hampshire, New York, Pennsylvania, West Virginia, Tennessee, Alabama, and Georgia. The total area covered by this control was about 10,200 square miles, thus making available thirty-seven 15-minute and two 30-minute quadrangles in which to prosecute further topographic surveys. In the progress of this work 92 triangulation stations were permanently marked and their geodetic

positions determined, and 462 miles of primary traverse were run.

Maine.—During the latter portion of the season Mr. E. L. McNair, topographer, was engaged in extending primary triangulation up the valley of the Kennebec River. He succeeded in carrying the work from the neighborhood of Norridgewock to Moosehead Lake, thus completing the control of the entire Kennebec Valley. In the course of this work he marked 25 triangulation stations, of which he occupied 19, thus furnishing control for the topographic mapping of eleven 15-minute quadrangles, lying in portions of Kennebec, Franklin, Somerset, and Piscataquis counties.

New Hampshire.—Two 15-minute quadrangles in the southern portion of the State, covering portions of Hillsboro and Rockingham counties, were controlled by Mr. George T. Hawkins, topographer, who occupied 6 triangulation stations and located 3 others by intersections in May, 1903.

New York.—Mr. A. H. Thompson, geographer, and Messrs. E. L. McNair and Oscar Jones, topographers, were engaged—the first during the entire season and the latter two during the first half of the season only—in extending triangulation up the Genesee Valley in the western portion of the State, and in the southern foothills of the Adirondacks. These parties established and marked 32 stations, the positions of which were determined and so located as to control eight 15-minute quadrangles in portions of Cattaraugus, Chautauqua, Genesee, Wyoming, and Livingston counties. There were also run 110 miles of primary traverse, which furnished control for two additional 15-minute quadrangles in portions of Jefferson, Lewis, and Oswego counties.

Pennsylvania.—Mr. Sledge Tatum, topographer, was engaged for one month in extending triangulation in the central portion of the State. Seven signals were erected and the positions of four stations were determined. In the course of this work one quadrangle was controlled, covering portions of Juniata and Snyder counties. Two

15-minute quadrangles northeast of Pittsburg were controlled in May, 1903, by Mr. D. H. Baldwin, assistant topographer, who located seven new stations for this purpose.

West Virginia.—Mr. Tatum was engaged during the season in extending primary triangulation in the northern and western portions of the State. Mr. S. S. Gannett, geographer, in connection with his work in Ohio, also extended triangulation across the Ohio River for the control of certain quadrangles lying partly in West Virginia. During the season these parties established and marked 30 stations, 29 of which were occupied and their positions determined. These furnish control for eleven 15-minute quadrangles in portions of Lincoln, Wayne, Putnam, Mason, Wood, Wetzel, Preston, Tucker, and Taylor counties.

Tennessee-Alabama.—During the winter 154 miles of primary traverse were run by Mr. McNair for the control of the Mannie 30-minute quadrangle, embracing most of Wayne County and a portion of Lawrence County, with a spur line extending from Iron City, through Tuscumbia, Ala., to Tanyard triangulation station, near Town Creek. This control was supplemented in May, 1903, by a line 32 miles in length run by Mr. Tatum from a point near Abner, westward via Waynesboro across the quadrangle.

Georgia.—The Wilkes 30-minute quadrangle, covering portions of Elberton, Wilkes, Taliaferro, and Oglethorpe counties, was controlled by 166 miles of primary traverse in the spring of 1903 by Mr. McNair.

IN CENTRAL SECTION.

Ohio.—Five 15-minute quadrangles, covering portions of Tuscarawas, Guernsey, Muskingum, Monroe, and Washington counties, were controlled by 22 triangulation stations occupied by Mr. Hawkins; and eleven 15-minute quadrangles, covering portions of Fairfield, Hocking, Athens, Vinton, Meigs, Gallia, and Lawrence counties, were controlled by 26 triangulation stations occupied by Mr. Gannett. The work of Mr. Gannett was based on the transcontinental triangulation of the Coast and Geodetic

Survey, and connected with previous work in the northeastern part of the State, so that all triangulation in Ohio is now reduced to the United States standard datum. Two 15-minute quadrangles immediately north of Cincinnati, covering portions of Hamilton, Warren, and Butler counties, were controlled by 82 miles of primary traverse by Mr. J. R. Ellis, field assistant.

Alabama-Georgia.—One 30-minute quadrangle, covering portions of Chambers and Lee counties, Ala., and Troup, Harris, and Muscogee counties, Ga., was controlled by 137 miles of primary traverse by Mr. Ellis, extending from Opelika, along the Western Railway of Alabama, to Lagrange, Ga.; thence along the Macon and Birmingham Railway to Harris; thence along the Central of Georgia Railway, via Columbus, to Opelika.

Mississippi.—The Jackson 30-minute quadrangle was controlled by 140 miles of primary traverse by Mr. Ellis, extending from Vicksburg, along the Alabama and Vicksburg Railway, to Jackson, and also by several spur lines in the vicinity of the latter place.

Illinois.—The Peoria 15-minute quadrangle, in Peoria and Tazewell counties, was controlled by 101 miles of primary traverse by Mr. Ellis, extending northward from Havana, along the Chicago, Peoria and St. Louis Railway, to the southeast corner of the quadrangle, and thence around its borders.

Michigan.—Additional control for the Ann Arbor quadrangle was obtained by 41 miles of primary traverse by Mr. Ellis, extending approximately along the meridian 83° 30′, between Plymouth and Monroe triangulation stations.

Kentucky.—One 30-minute quadrangle, covering portions of Henderson, Webster, Daviess, McLean, Ohio, and Hancock counties, was controlled by 146 miles of primary traverse run by Mr. Ellis. The line starts from the Coast and Geodetic Survey astronomic pier at Henderson and follows the Louisville and Nashville Railroad to Elmwood; thence east and north along highways to Floral, where it was connected with the line run in 1900.

Kansas.—Two 30-minute quadrangles in southeastern Kansas, covering portions of Allen, Bourbon, Crawford, and Neosho counties, were controlled by 150 miles of primary traverse by Mr. Ellis, starting from the astronomic pier at Fort Scott.

Missouri.—The Gravois Mills and Eldon 15-minute quadrangles, in the central portion of the State, were controlled by 86 miles of primary traverse by Mr. Ellis.

North Dakota-Minnesota.—The Wahpeton 30-minute quadrangle was controlled by 142 miles of primary traverse by Mr. Hawkins, extending from Fargo southward, via Colfax, Hankinson, and Fairmount, to Wahpeton, thence northward into Minnesota to the starting point.

IN ROCKY MOUNTAIN SECTION.

Colorado-Wyoming.—In the fall of 1902 Mr. R. H. Chapman, topographer, extended triangulation northward from stations west of Greeley, Colo., to stations near Laramie, Wyo. In addition to reoccupying 6 old stations, Mr. Chapman established and occupied 11 new stations and located 16 points by intersection.

Colorado.—Mr. Frank Tweedy, topographer, extended triangulation over the Boulder and Niwot 15-minute quadrangles, locating 6 points.

Texas.—Mr. Arthur Stiles, topographer, obtained horizontal control for the Terlingua 30-minute quadrangle, including the Terlingua Special. In the spring of 1903 triangulation for the control of the Chisos Mountain 30-minute quadrangle was also in progress.

Wyoming.—Mr. W. H. Herron, topographer, extended triangulation westward from the line Alzada-Warren Peak to the western border of the Devils Tower 30-minute quadrangle, having established and occupied 4 new stations.

Montana.—An area of about 2,000 square miles in Choteau County was controlled by Mr. J. T. Stewart, field assistant, under the direction of Mr. H. L. Baldwin, jr., topographer. A base line 5.6 miles in length was measured along the railroad near Havre. From this

base triangulation was extended northeastward to the international boundary line and connected therewith. Azimuth observations were taken at one end of the base and also on the boundary line. Twenty-five stations were occupied, controlling portions of five 30-minute quadrangles.

IN PACIFIC SECTION.

Washington.—Triangulation control for three 30-minute quadrangles in southeastern Washington was extended southward from stations in the expansion of the Spokane base. In addition to reoccupying 2 old stations, 17 new stations were built and occupied and 4 points located by intersection by Mr. Hawkins.

California.—Four new stations for the control of the Coalinga Special map in Fresno County were occupied by Mr. A. H. Sylvester, topographer, in October. This work was based upon the positions of Hepsedam and Castle Mount of the Coast and Geodetic Survey. Additional control in the vicinity of Redding was obtained by Mr. Hawkins, who located 3 new stations.

Arizona-California.—During the winter months Mr. R. B. Robertson, field assistant, extended a system of quadrilaterals down the valley of the Colorado River, from the vicinity of Needles, Cal., to Yuma, Ariz., a linear distance of 175 miles. Forty stations were occupied and 26 located by intersections. This work depends upon stations in the expansion of the secondary base of the Coast and Geodetic Survey near Needles, and a check was obtained by connecting with stations Pilot and Azimuth of the United States and Mexican Boundary Commission survey near Yuma. A few of the stations in the vicinity of Yuma were selected, built, and occupied by Mr. Sylvester earlier in the season.

SURVEYS OF FOREST RESERVES.

IN ROCKY MOUNTAIN SECTION.

Arizona; Prescott, San Francisco Mountain, and Grand Canyon forest reserves.—The work in progress by Mr. Baldwin for the trigonometric control of the area between

Prescott and the Grand Canyon was discontinued in June, 1902. Twenty-three new stations were established and occupied, including 5 on the rim of the Grand Canyon. Mr. Stewart took up this work in the spring of 1903, carrying the triangulation northward to the boundary of the Grand Canyon Forest Reserve.

Arizona; Santa Catalina and Santa Rita forest reserves.—In March, 1903, Mr. T. M. Bannon, topographer, organized a party for securing control for the area between Florence and the international boundary near Nogales. Horizontal control was secured for an area of about 4,000 square miles, including the entire area of the Santa Catalina and Santa Rita forest reserves and the adjoining area on the south as far as the Mexican boundary line.

Montana; Flathead Forest Reserve.—Mr. Chapman selected stations and erected signals in northern Montana for the control of the western part of the Flathead reserve, thus connecting the triangulation brought up from the Helena base with that developed from the Spokane base. Mr. Chapman also measured a check base along the railroad near Kalispel.

IN PACIFIC SECTION.

Oregon; Wallowa Forest Reserve.—Triangulation in northeastern Oregon was extended from stations in the expansion of the Baker City base so as to control three 30-minute quadrangles. Fourteen stations were established and occupied by Mr. C. F. Urquhart, topographer.

OFFICE WORK.

The office computations of triangulation and primary traverse were under the charge of Mr. S. S. Gannett, as heretofore. He was assisted by Messrs. A. H. Thompson, George T. Hawkins, C. F. Urquhart, H. L. Baldwin, jr., R. H. Chapman, Sledge Tatum, E. L. McNair, J. R. Ellis, L. Scott Smith, and Gilbert Young. The results of this work have been summarized and published in Bulletin No. 216. In addition, certain geographic tables and formulas pertaining to work of the topographic branch were compiled and published in Bulletin No. 214.

The office adjustment of level circuits was made by Messrs. D. H. Baldwin, L. C. Fletcher, C. B. Kendall, L. S. Smith, and E. I. Ireland, under the general supervision of Mr. Gannett, and a manuscript list of the bench marks established by spirit leveling was prepared for publication as a bulletin.

The routine work of furnishing triangulation and leveling data to parties in the field and to persons outside the survey, in response to requests, increased greatly during the year. Mr. Joseph W. Kreuttner was assigned as typewriter in December, 1902.

A summary of the office computing during the fiscal year follows:

Summary of office work in computing, fiscal year 1902-3.

Topographic section, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Name of quadrangle.	Computer.
ATLANTIC.				
Maine:				
Kennebec Franklin Somerset Piscataquis	Reduction to center, station and figure adjustments, final computation of distances and positions.			E. L. McNair.
			Anson	C. B. Kendall.
New Hampshire: Hillsboro Rockingham	Reduction to center, final computation of distances and positions.			Geo. T. Hawkins.
Vermont			Brandon	C. B. Kendall.
New York: Chautauqua Genesee Wyoming	Reduction to center, station and figure adjustments, final computation of distances and positions.			A. H. Thompson.
Jefferson Lewis Oswego		Computation of 783 latitudes and departures and 112 geographic positions.		Sledge Tatum. J. I. Gayetty.
			Batavia Mount Morris Saint Regis Saranac Lake	C. B. Kendall.
			Chautauqua Clymer Falconer	L. S. Smith.
			Setauket	D. H. Baldwin.
			Adjustment of primary level net in western central part of State.	Do.

Summary of office work in computing, fiscal year 1902-3—Continued.

Topographic section, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Name of quadrangle.	Computer.
ATLANTIC—cont'd.				
Pennsylvania: Allegheny	Reduction to center, computation of distances and positions.			D. H. Baldwin.
Snyder, Perry	Final computation of distances and positions.			Sledge Tatum.
			Amity, Barnesboro, Curwensville, Ebensburg, Johnstown, Osceola, Patton, Rogersville	C. B. Kendall.
Maryland			Annapolis, Baltimore, Ellicott, Oxford, Nanticoke, Westminster	C. B. Kendall.
West Virginia: Mason, Wood, Putnam	Reduction to center, station and figure adjustments, final computation of distances and positions.			S. S. Gannett.
Lincoln, Wayne, Wetzel, Preston, Tucker, Taylor	Reduction to center, station and figure adjustments, final computation of distances and positions.			Sledge Tatum.
			Cameron, Mannington, Burnsville, Flatwood, Parkersburg, Vadis, Bruceton Mills	C. B. Kendall. D. H. Baldwin.
Tennessee: Lawrence, Wayne; Alabama: Lauderdale, Colbert		Computation of 2,070 latitudes and departures and 66 geographic positions.		Geo. T. Hawkins. E. L. McNair. Sledge Tatum.
Tennessee			Greeneville, Morristown, Roan Mountain, Mannie	C. B. Kendall.
Georgia: Elbert, Oglethorpe, Taliaferro, Wilkes		Computation of 1,345 latitudes and departures and 83 geographic positions.		E. L. McNair. Geo. T. Hawkins.

Summary of office work in computing, fiscal year 1902–3—Continued.

Topographic section, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Name of quadrangle.	Computer.
ATLANTIC—cont'd.				
North Carolina			Williamston Grimesland Vanceboro Newbern Parmele Winterville Ayden Trent River Tarboro Falkland Rocky Mount Wilson Springhope Kenly Selma Raleigh Edenton Hertford	D. H. Baldwin.
CENTRAL.				
Ohio:				
Tuscarawas Guernsey Muskingum Monroe Washington Fairfield Hocking Athens Vinton Meigs Gallia Lawrence	Reduction to center, station and figure adjustments, final computation of distances and positions.			S. S. Gannett. Geo. T. Hawkins.
Butler Hamilton Warren		Computation of 288 latitudes and departures and 53 geographic positions.		Geo. T. Hawkins. J. R. Ellis.
			Cadiz St. Clairsville Scio Flushing Wellsville Salineville Cleveland Canton Clarington Westerville	D. H. Baldwin. L. S. Smith.
Indiana			Evansville	D. H. Baldwin.
Illinois: Peoria Tazewell		Computati n of 346 latitudes and departures and 57 geographic positions.		Geo. T. Hawkins. L. S. Smith.
			Mount Carmel	L. S. Smith.

Summary of office work in computing, fiscal year 1902–3—Continued.

Topographic section, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Name of quadrangle.	Computer.
CENTRAL—cont'd.				
Michigan:				
Wayne		Computation of 112 latitudes and departures and 34 geographic positions.		Geo. T. Hawkins. L. S. Smith.
			Ann Arbor	L. S. Smith.
Kentucky:				
Henderson, Webster, Daviess, Ohio, McLean, Hancock		Computation of 600 latitudes and departures and 95 geographic positions.		Geo. T. Hawkins. J. R. Ellis.
			Beechgrove, Newburg	L. S. Smith.
Missouri:				
Morgan, Miller, Camden		Computation of 737 latitudes and departures and 56 geographic positions.		Geo. T. Hawkins. L. S. Smith.
			Gravois Mills, Eldon, Palmyra	L. S. Smith.
Alabama:				
Chambers, Lee; Georgia: Troup, Harris, Muscogee		Computation of 408 latitudes and departures and 85 geographic positions.	Dadeville	Geo. T. Hawkins. J. R. Ellis.
Mississippi:				
Warren, Hinds, Rankin		Computation of 371 latitudes and departures and 65 geographic positions.		Geo. T. Hawkins. J. R. Ellis.
Kansas:				
Allen, Bourbon, Crawford, Neosho		Computation of 390 latitudes and departures and 137 geographic positions.		Geo. T. Hawkins. Sledge Tatum.
Nebraska			Weeping Water.	L. S. Smith.
North Dakota:				
Cass, Richland; Minnesota: Wilkin, Clay		Computation of 265 latitudes and departures and 37 geographic positions.		Geo. T. Hawkins. L. S. Smith.
North Dakota			Wahpeton	L. S. Smith.
ROCKY MOUNTAIN.				
Colorado:				
Larimer, Weld; Wyoming: Laramie	Reduction to center, station and figure adjustments, final computation of distances and positions.			S. S. Gannett. R. H. Chapman.

Summary of office work in computing, fiscal year 1902–3—Continued.

Topographic section, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Name of quadrangle.	Computer.
ROCKY MOUNTAIN—continued.				
Colorado			Longmont; Fort Collins	E. I. Ireland.
Wyoming			Devils Tower; Sherman	D. H. Baldwin.
Montana: Choteau	Reduction to center, station and figure adjustments, computation of distances and positions.			S. S. Gannett. H. L. Baldwin, jr. R. H. Chapman. Gilbert Young.
			Fort Assinniboine; Big Sandy; Chinook; Harlem; Havre; Yantic	E. I. Ireland.
Arizona: Yavapai	Reduction to center, station and figure adjustments, final computation of distances and positions.			H. L. Baldwin, jr. R. H. Chapman.
			Santa Maria; Congress; Wickenburg; Phœnix; New River	D. H. Baldwin.
Utah: Summit	Computation of positions of 13 secondary points near Park City.			P. Chapman.
PACIFIC.				
Arizona: Mohave, Yuma. California: San Bernardino, San Diego	Reduction to center, station and figure adjustments, final computation of distances and positions.			S. S. Gannett. C. F. Urquhart.
			Ehrensburg; Needles; Parker; Yuma	S. S. Gannett.
			Santa Rosa	L. C. Fletcher.
			Precise line, Benicia to Tujunga.	Do.
Oregon: Baker, Union, Wallowa	Reduction to center, station and figure adjustments, final computation of distances and positions.			C. F. Urquhart.
Washington: Spokane, Whitman, Garfield, Asotin	Reduction to center, station and figure adjustments, final computation of distances and positions.			Geo. T. Hawkins.
			Osoyoos	L. C. Fletcher.

Division of Geography and Forestry.

During the summer of 1902 the work in geography and forestry was in charge of Mr. Henry Gannett, geographer, but in the fall, owing to Mr. Gannett's absence in the Philippines, where he was engaged in taking the census, the work was temporarily transferred to the hydrographic branch, in charge of Mr. F. H. Newell.

During the summer of 1902 Mr. Gannett was personally engaged in examining the conditions in central Utah, from which region many requests for the establishment of small reserves have been made for the protection of the farming industry. The establishment of these reserves was apparently hostile to the sheep grazers, and Mr. Gannett's purpose in visiting the region was not only to examine the condition of the lands, but to visit the parties in interest and endeavor to obtain a satisfactory basis of agreement among them. Such an agreement was reached upon the following terms: That the entire mountain region of Utah, which constitutes at present the summer range for sheep, be reserved; that in such portions of these reserves as contribute to the water supply of the agricultural settlements sheep grazing be prohibited; that the remaining portions of the reserves be allotted to the various sheep owners for extended periods, and that the number of sheep to be grazed upon a unit of area be restricted far below the present number. These terms were agreed to by the representatives of both the farming industry and the sheep industry.

The examination of the Uinta Reserve, in Utah, was commenced by Mr. F. G. Plummer. The examination of the San Francisco Mountain Reserve, in Arizona, which was commenced by Mr. J. B. Leiberg in the preceding season, was completed by Messrs. Arthur Dodwell and T. F. Rixon, as was also that of the Black Mesa Reserve, in the same Territory.

In the spring of 1903 an examination of the Gila River Reserve, in New Mexico, was commenced by Mr. Rixon. The Wichita Reserve, in Oklahoma Territory,

was examined by Mr. F. G. Plummer, and on its completion he returned to San Diego for the purpose of preparing from the notes of Messrs. Leiberg, Dodwell, and Rixon a report on the San Francisco Mountain Reserve, in Arizona. Mr. M. G. Gowsell was employed in the early part of the season in the examination of the lands adjacent to the western boundary of the Washington Forest Reserve, with reference to their addition to the reserve. On completion of this work he commenced the examination of the Lincoln Forest Reserve, in New Mexico. In the early part of the season Mr. J. B. Leiberg was employed in making an examination of the Little Belt Mountain Reserve, in Montana.

The total area examined during the season is estimated at 7,500 square miles.

HYDROGRAPHIC BRANCH.

The funds available for the work of the division of hydrography were doubled by the appropriation act of June 28, 1902. The operations under the reclamation law of June 17, 1902, were also, by authority of the Secretary of the Interior, intrusted to the officials of this division. As a consequence, it became necessary, for administrative purposes, to create a separate branch of the Geological Survey. This is known as the hydrographic branch, and includes the work of the division of hydrography, as described in the last annual report, pages 99 to 118. It also includes the reclamation service, organized by authority of the Secretary of the Interior to carry on the surveys and examinations authorized by the reclamation law. There has also been added a division whose work is that of studying geologic conditions governing the occurrence of underground waters, this being known as the division of hydrology. Certain investigations have also been segregated in what is known as the division of hydro-economics, these having to do with the quality of water and its effect on various industries.

The hydrographic branch has been in immediate charge of Mr. Frederick H. Newell, assisted by a consulting or

executive staff consisting of the heads of the various divisions and sections and by experts employed for their knowledge of various details, such as masonry or concrete construction, installation of power plants, electrical transmission, etc. Among these are Arthur P. Davis, supervising engineer; George Y. Wisner, of Detroit, Mich., consulting engineer; J. H. Quinton, of Los Angeles, Cal., consulting engineer; William H. Sanders, of Los Angeles, Cal., consulting engineer; Charles H. Fitch, engineer of diversion surveys; H. A. Storrs, electrical engineer, and others.

During the year three examinations were held by the Civil Service Commission for the purpose of securing additional assistants in the hydrographic branch. As a result of these examinations, experienced hydrographers, irrigation engineers, and competent assistants were obtained, all responsible positions being under the classified service. The positions of resident or local hydrographers, which in previous years had been held largely by field men, were at the end of the fiscal year filled by experienced men, selected by competitive examination. In addition there are a considerable number of temporary field employees; but what may be called the regular force consists of young or middle-aged men who secured and retain their positions wholly through merit and ability.

Division of Hydrography.

The operations of this division were considerably expanded, but in the main continued along the lines described in previous reports, the work being under the immediate charge of Mr. F. H. Newell, assisted by various men in the office and in the field. Mr. George B. Hollister, hydrographer, served as executive officer at Washington and had charge of the general conduct of affairs. The disbursing for a considerable part of the year was done by Mr. J. W. Spencer, and the bookkeeping by Mrs. J. T. Davis. The office computing was carried on by Mr. J. C. Hoyt, assisted by Mr. F. H. Brundage, the drafting by Mr. H. V. Leménager, and the

instrumental equipment, rating of meters, and similar duties were performed by Mr. E. G. Paul. The inspection of river stations, methods, and results was carried on by Mr. E. C. Murphy. In addition to the above-named employees, with headquarters at Washington, there were a considerable number of local men or resident hydrographers employed in various parts of the country. Complete descriptions of the river stations, together with the data collected and the results obtained from the discussion of these data, are published in Water-Supply Papers Nos. 82 to 85.

EASTERN SECTION OF HYDROGRAPHY.

Mr. N. C. Grover, of Orono, Me., assisted by Mr. F. E. Pressey, carried on work in the State of Maine, the intention being to extend this to the larger part of New England. Prof. H. K. Barrows began the establishment of a few river stations in Vermont, and assistance was rendered by Mr. Charles A. Holden and others.

Mr. Robert E. Horton, assisted by Prof. C. C. Covert and Mr. F. H. Tillinghast, carried on work in New York State, in cooperation with the State engineer and officials of New York City.

Mr. Edwin G. Paul maintained river stations within convenient reach of the city of Washington, these being mainly in the States of Maryland, Pennsylvania, and Virginia.

Messrs. B. M. Hall, consulting engineer, M. R. Hall, hydrographer, and E. W. Myers, assisted by Messrs. James M. Giles, B. F. Drane, and others, carried on river work in the States of North Carolina, South Carolina, Georgia, Alabama, and adjacent areas.

Mr. Marshall O. Leighton, with headquarters at Chicago, Ill., assisted by Messrs. Frank W. Hanna, Edward Johnson, jr., Alf C. Lootz, L. R. Stockman, W. B. Hoag, Emil H. Heilbron, Karl C. Kastberg, and others, established and maintained river stations in the areas accessible from Chicago, the work being mainly in the States of Wisconsin, Illinois, Indiana, Ohio, Michigan, Iowa, Missouri, Minnesota, and Kentucky.

Prof. Thomas U. Taylor, Austin, Tex., continued river work in that State.

Below are given, in geographic order, descriptions of the operations in the various States or groups of States included in the eastern section of hydrography, and also the names of the engineers or resident hydrographers under whose charge the work was done.

Maine.—Measurements of the rivers at various points were continued through cooperation with the State, the field work being under the charge of Mr. N. C. Grover, assisted by Mr. F. E. Pressey.

New Hampshire.—Measurements on the Connecticut River at Orford were continued under the direction of Prof. Charles A. Holden.

Vermont.—During the latter part of the year systematic measurements were started on several streams under the direction of Prof. H. K. Barrows.

Massachusetts.—The metropolitan water and sewerage board continued to give the results of the flow of the streams in the drainage areas which furnish the Boston water supply. Mr. R. A. Hale, assistant engineer, Lawrence, Mass., continued his determinations of the flow of the Merrimac.

Rhode Island.—Measurements on the Blackstone River were made during part of the year in cooperation with Prof. John E. Hill and his students of Brown University.

Connecticut.—Measurements were continued on a few small streams in connection with the study of the water supply for New York City.

New York.—Systematic measurements, through cooperation with the State, were continued under the direction of Mr. Robert E. Horton. The measurements of streams for the proposed water supply of New York City were made by Mr. F. H. Tillinghast. Investigations on the accuracy of stream measurements and the flow over dams were continued by Mr. E. C. Murphy and Prof. G. S. Williams, at the hydraulic laboratory of Cornell University.

New Jersey.—Regular stations were maintained on the Passaic and Pompton rivers, and several miscellaneous

measurements were made in other parts of the State, the work being carried on by Mr. George B. Hollister.

Pennsylvania and Maryland.—Systematic measurements of the Susquehanna and Delaware rivers were carried on under the direction of Mr. E. G. Paul and other members of the office force, cooperation in Maryland being had with Prof. William B. Clark, director of the Maryland geological survey.

Virginia and West Virginia.—Several regular stations were maintained on the more important rivers of these States under the direction of Prof. D. C. Humphreys and of Mr. E. G. Paul.

North Carolina and South Carolina.—The work in these States was continued by Mr. E. W. Myers. Mr. J. A. Holmes gave many valuable suggestions in regard to this work.

Georgia, Alabama, and Tennessee.—The stations in these States were carried on mainly under the direction of Messrs. B. M. Hall and Max R. Hall. Valuable assistance was given by the United States Weather Bureau, the Army engineers, and Prof. Eugene A. Smith, State geologist of Alabama. Several of the measurements at stations in Tennessee were made by Mr. E. W. Myers.

Ohio.—Measurements were continued in this State during the first half of the year under the direction of Mr. Benjamin H. Flynn, engineer for the Ohio State board of health. After Mr. Flynn's death the work was under the direction of Mr. Edward Johnson, jr.

Indiana.—Measurements were carried on in cooperation with Prof. George E. Waesche, on the Wabash River at Lafayette. Arrangements were made to continue this work, so that stations will be maintained on the principal rivers in this State.

Illinois.—During the latter portion of the year measurements were made at regular stations on the Illinois River and on its principal tributaries in cooperation with Mr. E. H. Heilbron, of the Chicago sanitary district.

Michigan.—Systematic measurements were continued

during the year on several of the important streams in this State under the direction of Mr. Robert E. Horton.

Wisconsin.—Arrangements were made to carry on systematic hydrographic studies in this State with the assistance of Prof. E. A. Birge, director of the Natural History Survey of Wisconsin, and Prof. L. S. Smith, of the University of Wisconsin. Most of the work in the field has been performed by Mr. L. R. Stockman.

Minnesota.—A few stations were maintained in this State by the late Prof. C. M. Hall. After Professor Hall's death arrangements were made with Prof. W. B. Hoag, of Minneapolis, to continue the work.

Iowa.—Several stream-measurement stations were established in this State in cooperation with Mr. Karl C. Kastberg, assistant city engineer, Des Moines.

Missouri.—Arrangements were made to carry on systematic measurements in the central part of Missouri under the direction of Mr. I. W. McConnell, of Rolla. Prof. J. L. Van Ornum was also to cooperate in making measurements in the eastern part of the State, but he was unable to continue the work, and the stations were turned over to Mr. McConnell.

WESTERN SECTION OF HYDROGRAPHY.

The western section of the hydrographic division includes the thirteen States and three Territories enumerated in the reclamation law. In this part of the country the measurement of streams was carried on under the immediate direction of the resident or district engineers of the reclamation service. The men who were employed as hydrographers and engaged in river work are: W. W. Schlecht and W. Richins in Arizona; S. G. Bennett, W. B. Clapp, and others in California; A. L. Fellows, M. C. Hinderlider, Fillmore Cogswell, and others in Colorado; N. S. Dils in Idaho; W. G. Russell in Kansas; J. S. Baker in Montana; O. V. P. Stout and J. C. Stevens in Nebraska; L. H. Taylor in Nevada; Elwyn F. Chandler, Charles M. Hall (deceased), Daniel E. Willard, and others in North Dakota; W. G. Russell and Ferdinand Bonstedt in Oklahoma; George L. Swendsen and H. S. Reed in

Utah; Sydney Arnold in Washington; and A. J. Parshall in Wyoming.

Arizona.—Systematic measurements have been carried on at various places on the Verde and Salt rivers by Messrs. W. W. Schlecht and W. Richins under the general supervision of Mr. Arthur P. Davis. Stations were also maintained on the Colorado River and many miscellaneous measurements were made in that section by Mr. W. D. Smith under the direction of Mr. J. B. Lippincott.

California.—Extensive investigations of the flow of the various streams in this State were continued under the general direction of Mr. J. B. Lippincott, assisted by Messrs. S. G. Bennett and W. B. Clapp. A water-supply paper was prepared by Mr. Lippincott, containing a complete résumé of the results of stream measurements made in this State during previous years.

Colorado.—Systematic measurements were continued on the principal streams under the direction of Messrs. A. L. Fellows, M. C. Hinderlider, and Fillmore Cogswell. The results of these measurements have been published both in the Water-Supply series and in the Colorado State engineer's report.

Idaho.—Stream measurements were continued at several stations in this State through the cooperation of Mr. D. W. Ross, State engineer. The field operations were carried on by Mr. N. S. Dils.

Kansas.—River stations were maintained as in former years by Mr. W. G. Russell.

Montana.—Measurements were continued during the year by Mr. J. S. Baker, hydrographer in the field. Assistance was also given by Prof. Samuel Fortier. Under the direction of Mr. Cyrus C. Babb several stations were maintained on the St. Mary River and principal tributaries.

Nebraska.—Systematic measurements of the rivers of this State were continued under the direction of Prof. O. V. P. Stout by Mr. J. C. Stevens.

Nevada.—Mr. L. H. Taylor continued the measurements on the principal streams in this State. During a portion of the year Mr. E. C. Murphy had charge of the field work.

New Mexico.—Several stations were maintained on the Rio Grande by Mr. W. W. Follett, consulting engineer of the International (Water) Boundary Commission, the results being made available for the use of this Survey.

North Dakota.—Stations were maintained in this State under the direction of Prof. E. F. Chandler, D. E. Willard, and the late Prof. C. M. Hall. Since Professor Hall's death arrangements have been made to continue the work on the principal streams under the direction of Mr. F. E. Weymouth, who is investigating the irrigation possibilities of the western end of the State.

Oklahoma.—The stations in Oklahoma were continued, as in former years, under the direction of Messrs. W. G. Russell and Ferdinand Bonstedt.

Oregon.—A few stations were maintained on the principal rivers of this State under the direction of Messrs. Sydney Arnold and J. T. Whistler.

South Dakota.—Measurements of the Sioux River, in the eastern part of the State, and of streams from the Black Hills were made under the direction of Prof. O. V. P. Stout.

Texas.—Measurements of several of the important rivers were made by Prof. Thomas U. Taylor, of the State University, in connection with his studies on irrigation. Measurements at various points along the Rio Grande were made by the engineers of the International (Water) Boundary Commission, under the direction of Mr. W. W. Follett, consulting engineer, the results being given to this survey.

Utah.—Measurements of the streams of this State were continued by Prof. George L. Swendsen and H. S. Reed.

Washington.—Hydrographic work was continued in this State by Mr. Sydney Arnold, and systematic measurements of the streams which drain into Puget Sound were carried on by Mr. T. A. Noble, of Seattle.

Wyoming.—Mr. A. J. Parshall continued stream measurements on several important streams. Special investigations were made on the Crow Creek drainage area.

LOCATION OF RIVER MEASUREMENTS.

The following list, arranged by States, and the accompanying map (Pl. XXV) show the points at which the principal river measurements were maintained. At some of these data for gage height were had from the United States Weather Bureau, from various municipalities, or from corporations. More complete facts concerning these points may be found in Water-Supply Papers Nos. 82–85, relating to operations for the calendar year 1902.

Gaging stations, by States, maintained in 1902.

River.	Station.	River.	Station.
ALABAMA.		CALIFORNIA—cont'd.	
Alabama	Montgomery.	Carson (West Fork)	Woodfords.
Do	Selma.	Donner Creek	Donner Ice Co.'s dam, Truckee.
Black Warrior	Cordova.		
Do	Tuscaloosa.	Feather	Oroville.
Black Warrior (Locust Fork).	Palos.	Independence Creek.	Independence Lake, Overton.
Cahaba	Centerville.	Kaweah	Three Rivers.
Coosa	Riverside.	King	Red Mountain, Sanger.
Hillabee Creek	Alexander.	Malibo Creek	Calabasas.
Talladega Creek	Nottingham.	Merced	Merced Falls.
Tallapoosa	Milstead.	Modesto canal	Indian Hill flume.
Do	Sturdevant.		
ARIZONA.		Mohave	Victorville.
Colorado	Bulls Head.	Mokelumne	Electra.
Do	Yuma.	Mono Creek	Dam site (cable station).
Gila	San Carlos.		
Salt	McDowell.	Prosser Creek	Prosser Creek Ice Co.'s dam, Boca.
Do	Reservoir site below Tonto Creek, Livingstone.	Sacramento	Iron Canyon, Red Bluff.
		San Gabriel River and canals.	Azusa.
Tonto Creek	Livingstone.	San Lorenzo Creek	King City.
Verde	McDowell.	Santa Ana	Warmsprings.
CALIFORNIA.		Santa Ynez	Cable station.
Arroyo Seco	Pettitt's ranch, Soledad.	Stanislaus	Knights Ferry.
		Stony Creek	Julian's ranch, Fruto.
Cache Creek	Lower Lake.		
Do	Yolo.	Susan	Susanville.

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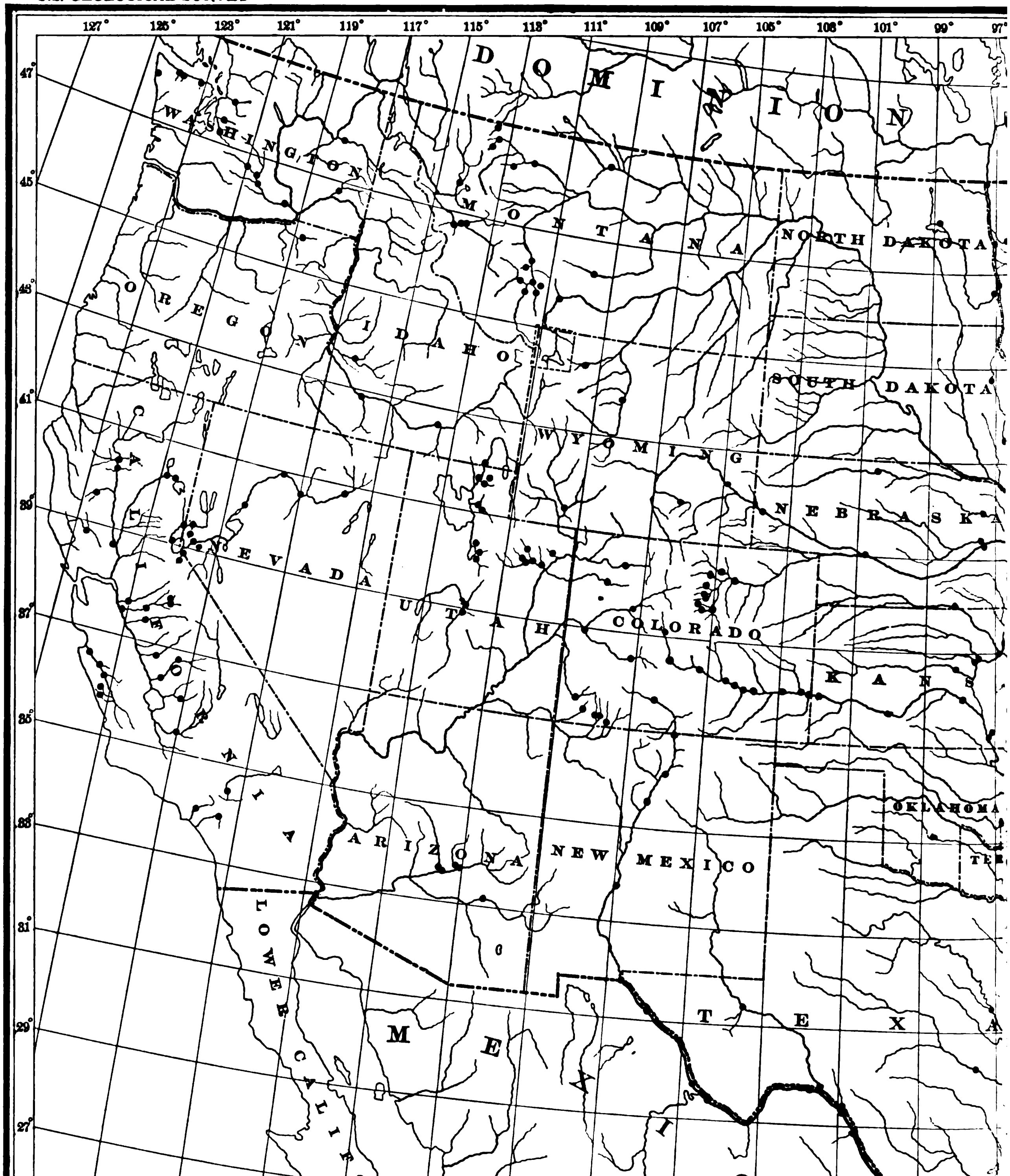
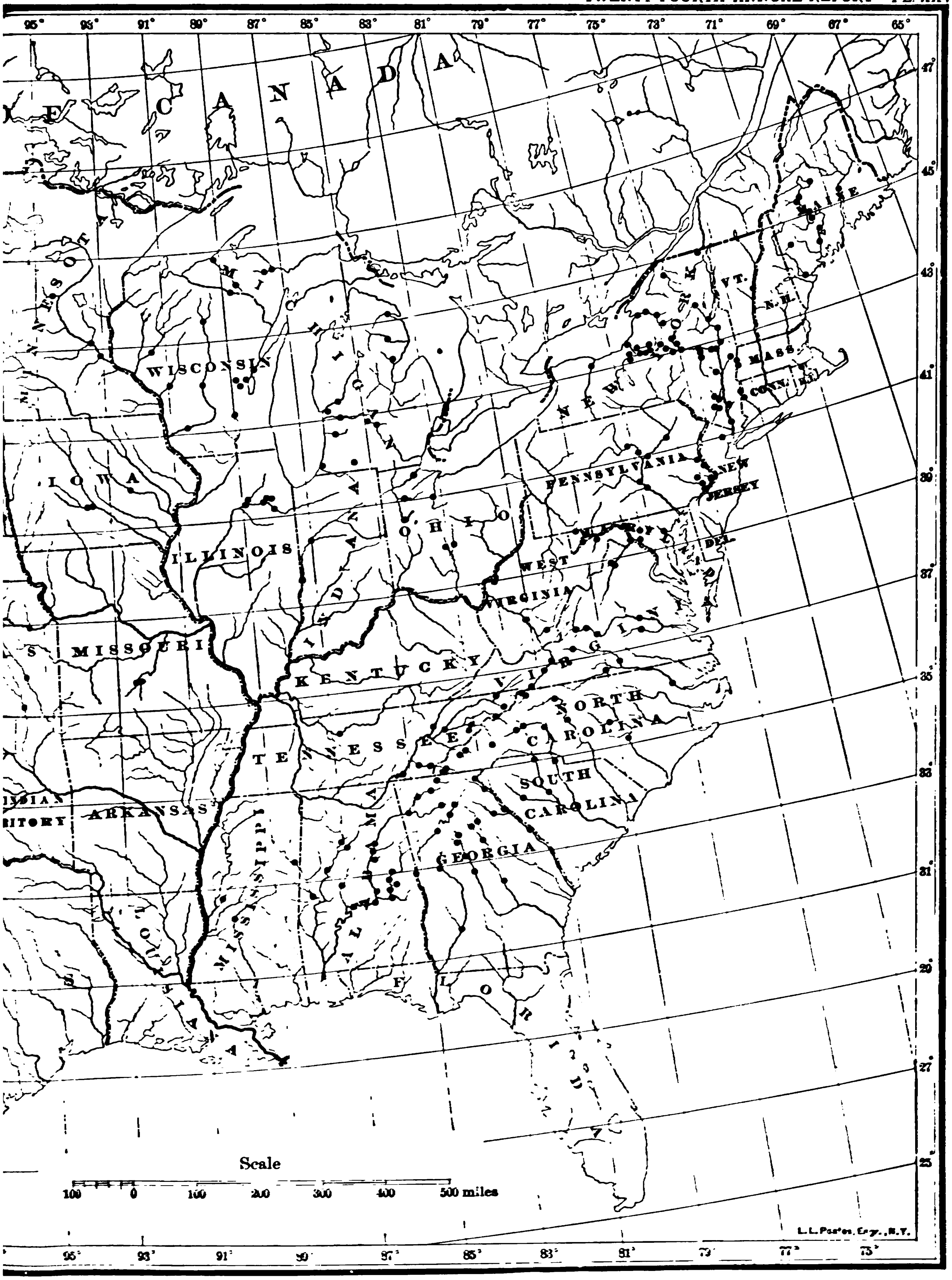
Gaging stations, by States, maintained in 1902.

River.	Station.	River.	Station.
ALABAMA.		CALIFORNIA—cont'd.	
Alabama	Montgomery.	Carson (West Fork)	Woodfords.
Do	Selma.	Donner Creek	Donner Ice Co.'s dam, Truckee.
Black Warrior	Cordova.	Feather	Oroville.
Do	Tuscaloosa.	Independence Creek	Independence Lake, Overton.
Black Warrior (Locust Fork).	Palos.	Kaweah	Three Rivers.
Cahaba	Centerville.	King	Red Mountain, Sanger.
Coosa	Riverside.	Malibo Creek	Calabasas.
Hillabee Creek	Alexander.	Merced	Merced Falls.
Talladega Creek	Nottingham.	Modesto canal	Indian Hill flume.
Tallapoosa	Milstead.	Mohave	Victorville.
Do	Sturdevant.	Mokelumne	Electra.
ARIZONA.		Mono Creek	Dam site (cable station).
Colorado	Bulls Head.	Prosser Creek	Prosser Creek Ice Co.'s dam, Boca.
Do	Yuma.	Sacramento	Iron Canyon, Red Bluff.
Gila	San Carlos.	San Gabriel River and canals.	Azusa.
Salt	McDowell.	San Lorenzo Creek	King City.
Do	Reservoir site below Tonto Creek, Livingstone.	Santa Ana	Warmsprings.
Tonto Creek	Livingstone.	Santa Ynez	Cable station.
Verde	McDowell.	Stanislaus	Knights Ferry.
CALIFORNIA.		Stony Creek	Julian's ranch, Fruto.
Arroyo Seco	Pettitt's ranch, Soledad.	Susan	Susanville.
Cache Creek	Lower Lake.		
Do	Yolo.		



MAP OF THE UNITED STATES, SHOW



ING LOCATION OF RIVER STATIONS.

Gaging stations, by States, maintained in 1902—Continued.

River.	Station.	River.	Station.
CALIFORNIA—cont'd.		COLORADO—cont'd.	
Triumpho Creek	Calabasas.	South Platte	Julesburg.
Truckee	Nevada-California State line, Mystic.	Do	Kersey.
		Do	South Platte.
Do	Tahoe.	Supply ditch	Lyons.
Tule	Portersville.	Uncompahgre	Colona.
Tuolumne River and Turlock canal.	Lagrange.	Do	Delta.
		Do	Montrose.
Turlock canal	Morgan flume.	CONNECTICUT.	
Do	Near Snake River flume.	Byram	Glenville.
Walker (West Fork).	Upper end of Antelope Valley, Coleville.	Byram (East Branch)	Greenwich.
		Do	Jones.
COLORADO.		Housatonic	Gaylordsville.
Animas	Durango.	Mianus	Stamford.
Arkansas	Canyon.	GEORGIA.	
Do	Granada.	Alcovy	Covington.
Do	Nepesta.	Apalachee	Buckhead.
Do	Lajunta.	Broad (of Georgia)	Carlton.
Do	Pueblo.	Chattahoochee	Gainesville.
Do	Rockyford.	Do	Oakdale.
Do	Salida.	Do	West Point.
Big Thompson Creek	Arkins.	Do	Norcross.
Cache la Poudre	Greeley.	Coosa	Rome.
Cimarron	Cimarron.	Coosawattee	Carters.
Clear Creek	Forkscreek.	Etowah	Canton.
Conejos	Mogote.	Flint	Albany.
Dolores	Dolores.	Do	Woodbury.
Florida	Durango.	Kinchafoonee Creek	Albany.
Grand	Glenwood Springs.	Muckalee Creek	Do.
Do	Palisades.	Oconee	Dublin.
Gunnison	Cory.	Ocmulgee	Flovilla.
Do	Iola.	Do	Macon.
Do	Whitewater.	Savannah	Augusta.
Handy ditch	Arkins.	IDAHO.	
Los Pinos	Ignacio.		
Oxford Farmers canal.	Nepesta.	Bear	Battlecreek, Preston.
Rio Grande	Cenicero.	Blackfoot	Presto.
Do	Del Norte.	Boise	Boise.
St. Vrain Creek	Lyons.	Bruneau	Grandview.
South Platte	Denver.	Fall	Marysville.

Gaging stations, by States, maintained in 1902—Continued.

River.	Station.
IDAHO—continued.	
Snake	Montgomery, Minidoka.
Snake (North Fork)	Ora.
Succor Creek	Homedale.
Teton	St. Anthony.
Weiser	Weiser.
Willow Creek	Prospect.
ILLINOIS.	
Desplaines	Mouth of Kankakee, Channahon.
Do	Mouth of Jackson Creek, Channahon.
Fox	Ottawa.
Illinois	Peoria.
Do	Lasalle.
Do	Ottawa.
Do	Seneca.
Do	Minooka.
Rock	Rockton.
Sangamon	Springfield.
INDIANA.	
Tippecanoe	Delphi.
Wabash	Lafayette.
Do	Terre Haute.
IOWA.	
Cedar	Cedar Rapids.
Des Moines	Des Moines.
Do	Keosauqua.
Iowa	Manchester.
Do	Marshalltown.
Maquoketa	Manchester.
Raccoon	Des Moines.
KANSAS.	
Arkansas	Arkansas City.
Do	Coolidge.
Do	Dodge.
Do	Hutchinson.
Do	Syracuse.
KANSAS—continued.	
Blue	Manhattan.
Kansas	Lecompton.
Marais des Cygnes	Ottawa.
Neosho	Iola.
Republican	Junction.
Saline	Salina.
Smoky Hill	Ellsworth.
Solomon	Niles.
Verdigris	Liberty.
Walnut	Arkansas City.
MAINE.	
Androscoggin	Dixfield.
Carrabassett	North Anson.
Dead	The Forks.
Kennebec	North Anson.
Do	The Forks.
Mattawamkeag	Mattawamkeag.
Messalonskee	Waterville.
Moose	Rockwood.
Penobscot	Montague.
Penobscot (east branch)	Grindstone.
Piscataquis	Low's bridge, Foxcroft.
Roach	Roach River.
St. Croix	Sprargues Falls, Baring.
MARYLAND.	
Antietam Creek	Sharpsburg.
Monocacy	Frederick.
Patapsco	Woodstock.
Potomac	Point of Rocks.
Youghiogheny	Friendsville.
MICHIGAN.	
Au Sable	Bamfield.
Black	Cheboygan.
Boardman	Traverse City.
Carp	Marquette.
Crockery Creek	Ravenna.
Dead	The Hoist, Negaunee.

Gaging stations, by States, maintained in 1902—Continued.

River.	Station.	River.	Station.
MICHIGAN—cont'd.		MISSOURI—cont'd.	
Escanaba	Escanaba.	Piney (Big)	Hooker.
Fawn	Sturgis.	Piney (Little)	Arlington.
Grand	Grand Rapids.	MONTANA.	
Do	North Lansing.		
Iron	Riverton mine.	Big Blackfoot	Bonner.
Kalamazoo	Allegan.	Bitterroot	Grantsdale.
Manistee	Sherman.	Gallatin	Logan.
Menominee	Iron Mountain.	Gallatin (West)	Salesville.
Muskegon	Newaygo.	Jefferson	Sappington.
Ontonagon	Rockland.	Madison	Norris, Red Bluff.
Ontonagon (West Branch).	Do.	Marias	Shelby.
		Middle Creek	Bozeman.
Red Cedar	Agricultural College.	Milk	Havre.
Do	Okemos.	Do	Malta.
Rifle	Omer.	Missoula	Missoula.
St. Joseph	Buchanan.	Missouri	Cascade.
Do	Mendon.	Do	Townsend.
Tittabawassee	Freeland.	Musselshell	Shawmut.
Thunder Bay	Alpena.	St. Mary	Dam site.
White Pigeon	Sturgis.	Do	International line, Cardston, Alberta.
MISSISSIPPI.			
Pearl	Jackson.	Do	Main.
Tombigbee	Columbus.	Swiftcurrent Creek	Henkel's ranch, St. Mary.
Yazoo	Yazoo.	Two Medicine Creek	Midvale.
MINNESOTA.		Yellowstone	Carter's bridge, Livingston.
Crow Wing	Pillager.	NEBRASKA.	
Minnesota	Mankato.		
Mississippi	Sauk Rapids.	Elkhorn	Arlington.
Red	Moorhead.	Do	Norfolk.
Red Lake River	Crookston.	Loup	Columbus.
Rum	St. Francis.	Mill Race	Superior.
St. Louis	Cloquet.	Niobrara	Niobrara.
MISSOURI.		Do	Valentine.
		North Platte	Bridgeport.
Gasconade	Arlington.	Do	Mitchell.
Meramec	Fenton.	Do	North Platte.
Meramec (Dry Fork)	St. James.	Platte	Columbus.
Meramec Spring	Meramec.	Do	Lexington.
Meramec	Mouth of Spring Branch, Meramec.	Republican	Superior.
		South Platte	Big Spring.

Gaging stations, by States, maintained in 1902—Continued.

River.	Station.	River.	Station.
NEVADA.		NEW JERSEY—cont'd.	
Carson	Empire.	Raritan (South Branch).	Stanton.
Carson (East Fork)	Rodenbah's ranch, Gardnerville.	NEW YORK.	
Humboldt (North Fork).	Elburz, near Halleck.	Beaver	Croghan.
Humboldt	Golconda.	Black	Felts Mills.
Do	Oreana.	Byram (Main)	Pemberwick.
Do	Palisade.	Do	Port Chester.
Humboldt (South Fork).	Pattanni's ranch.	Byram (West Branch).	Do.
Marys	Bradley's home ranch, Deeth.	Canada Creek (East)	Dolgeville.
		Canada Creek (West)	Twin Rock bridge.
Pine Creek	Palisade.	Carlls (East Branch)	Babylon.
Mud Lake slough	Wadsworth.	Carlls (West Branch)	Do.
Truckee	Pyramid Lake Indian Agency.	Catskill Creek (West Branch).	South Cairo.
Do	Vista.	Chenango	Binghamton.
Walker	Wabuska.	Chittenango	Chittenango.
Walker (East Fork)	Ross ranch, Yerington.	Connecticut	South Haven.
NEW MEXICO.		Connectquot (East Branch).	East Islip.
Hondo	Reservoir site.	Connectquot (West Branch).	Do.
Do	Roswell.		
Pecos	Carlsbad.	Darrell	Ithaca.
Do	Roswell.	Delaware	Port Jervis.
Do	Santa Rosa.	Do	Hancock.
Rio Grande	Embudo.	Delaware (East Branch).	Do.
Do	San Marcial.		
Do	Rio Grande.	Delaware and Hudson canal.	Creek locks.
NEW HAMPSHIRE.		Doxsee	Islip.
Androscoggin	Errol dam.	Esopus Creek	Kingston.
Do	Shelburne.	Do	Olive Bridge.
Connecticut	Orford.	Fishkill	Glenham.
NEW JERSEY.		Foundry Brook	Cold Spring.
Delaware	Lambertville.	Genesee	Geneseo.
Millstone	East Millstone.	Do	Mount Morris.
Musconetcong	Asbury.	Do	Rochester.
Passaic	Two Bridges.	Graefenberg	Utica.
Pompton	Do.	Hartford	Do.
Raritan	Bound Brook.	Honeoye Creek	East Rush.
Raritan (North Branch).	Far Hills.	Hudson	Fort Edward.
		Do	Mechanicville.

Gaging stations, by States, maintained in 1903—Continued.

River.	Station.	River.	Station.
NEW YORK—cont'd.		NORTH CAROLINA.	
Indian	Indian Lake dam.	Cape Fear	Fayetteville.
Johnson	Utica.	Catawba	Morganton.
Massapequa Creek	Long Island.	Dan	Madison.
Mianus	Bedford.	Hiwassee	Murphy.
Mohawk	Dunsbach Ferry.	Little Tennessee	Judson.
Do	Little Falls.	Nottely	Ranger.
Do	Utica.	Roanoke	Neal, near Kelford.
Moose	Moose River.	Rockfish Creek	Brunt.
Navesink	Port Jervis.	Tuckasegee	Bryson.
Oak Orchard	Medina.	Yadkin	North Wilkesboro.
Oak Orchard Feeder	Do.	Do	Salisbury.
Oneida	Oak Orchard.	NORTH DAKOTA.	
Oriskany Creek	Oriskany.	Cannon Ball	Stevenson.
Orowoc	East Islip.	Heart	Richardson.
Oswegatchie	Ogdensburg.	James	Lamoure.
Oswego	Fulton.	Little Missouri	Medora.
Do	High dam.	Mouse	Minot.
Do	Minetto.	Pembina	Neche.
Peconic	Calverton.	Red	Emerson, Manitoba.
Raquette	Hannawa Falls.	Do	Grand Forks.
Reels Creek	Utica.	Do	Fargo.
Richelieu	Fort Montgomery.	Sheyenne	Haggart.
Rondout	Honk Falls.	OHIO.	
Do	Rosendale.	Auglaize	Defiance.
Salmon	Pulaski.	Blanchard	Ottawa.
Sampawams Creek	Babylon.	Black	Elyria.
Saranac	Plattsburg.	Cross Creek	Mingo Junction.
Do	Saranac Lake.	Cuyahoga	Cleveland.
Schoharie	Mill Point.	Jonathan Creek	Powells.
Do	Prattsville.	Licking	Pleasant Valley.
Schroon	Warrensburg.	Mahoning	Youngstown.
Seneca	Baldwinsville.	McMahon	Steel.
Skaneateles Outlet	Willow Glen.	Olentangy	Columbus.
Starch Factory Creek	Utica.	Ottawa	Lima.
Susquehanna	Binghamton.	Scioto	Columbus.
Tenmile	Dover Plains.	Tiffin	Defiance.
Wallkill	New Paltz.		
Wappinger	Wappinger Falls.		

Gaging stations, by States, maintained in 1902—Continued.

River.	Station.
OKLAHOMA.	
Canadian (North Fork).	Elreno.
Washita	Anadarko.
OREGON.	
Malheur Lake	The Narrows.
McCay Creek	Pendleton.
Umatilla	Gibbon.
Do	Pendleton.
Do	Yoakum.
Walla Walla	Milton.
Walla Walla (South Fork).	Do.
PENNSYLVANIA.	
Juniata	Newport.
Lehigh	South Bethlehem.
Susquehanna	Harrisburg.
Do	Wilkesbarre.
Susquehanna (North Branch).	Danville.
Susquehanna (South Branch).	Williamsport.
SOUTH CAROLINA.	
Broad (of the Carolinas).	Alston.
Catawba	Rockhill.
Saluda	Waterloo.
Savannah	Calhoun Falls.
Wateree	Camden.
SOUTH DAKOTA.	
Belle Fourche	Belle Fourche.
Big Sioux	Watertown.
Box Elder Creek	Black Hawk.
Cheyenne	Edgemont.
Rapid	Rapid.
Red Water	Menesela.
Spearfish	Toomey's ranch.
Spring Creek	Blair ranch.
TEXAS.	
Brazos	Richmond.
Do	Waco.
Colorado (of Texas)	Austin.
TEXAS—continued.	
Colorado (of Texas)	Columbus.
Devils	Devils River.
Guadalupe	Cuero.
Pecos	Moorhead.
Do	Pecos.
Rio Grande	Eagle Pass.
Do	El Paso.
Do	Fort Hancock.
Do	Mouth of Devils River.
Do	Langtry.
Do	Moorhead.
Do	Presidio.
Do	Do.
Trinity	Riverside.
TENNESSEE.	
Cumberland	Nashville.
French Broad	Oldtown.
Hiwassee	Charleston.
Do	Reliance.
Holston (South Fork)	Bluff City.
Nolichucky	Greeneville.
Okoee	McCays.
Pigeon	Newport.
Tennessee	Chattanooga.
Do	Knoxville.
Watauga	Elizabethton.
UTAH.	
Ashley	Vernal.
Bear	Collinston.
Blacksmith Fork	Hyrum.
Duchesne	Price road bridge.
Lake Creek	Near mouth.
Logan	Logan.
Provo	Provo.
San Pitch	Gunnison.
Sevier	Do.
Uinta	Fort Duchesne.
Do	Ouray School, Leland.
Uinta	Whiterocks.

Gaging stations, by States, maintained in 1902—Continued.

River.	Station.	River.	Station.
UTAH—continued.		WEST VIRGINIA.	
Weber	Uinta.	Cheat	Morgantown.
Whiterocks	Whiterocks.	Greenbrier	Alderson.
VERMONT.		New	Fayette.
Lamoille	West Milton.	Potomac (North Fork).	Piedmont.
Missisquoi	Swanton.	Shenandoah	Millville.
Otter Creek	Middlebury.	WISCONSIN.	
Winooski	Winooski.	Black	Melrose.
VIRGINIA.		Catfish or Yahara	Madison.
Appomattox	Mattoax.	Chippewa	Eau Claire.
Dan	South Boston.	Flambeau	Ladysmith.
James	Buchanan.	Fond du Lac (East Branch).	Fond du Lac.
Do	Cartersville.	Fond du Lac (West Branch).	Do.
James (North Fork)	Glasgow.	Fox	Omro.
James	Holcombs Rocks.	Do	Wrightstown.
New	Oldtown.	Lake Mendota	Madison.
Do	Radford.	Wisconsin	Merrill.
Roanoke	Roanoke.	Do	Muscoda.
Shenandoah (North Branch).	Riverton.	Do	Necedah.
Shenandoah (South Branch).	Front Royal.	Wolf	Winneconne.
Smith	Waller.	WYOMING.	
Staunton	Randolph.	Bighorn	Thermopolis.
WASHINGTON.		Clear Creek	Buffalo.
Cedar	North Bend.	Cruze Ditch	Story.
Do	Maple Valley.	Green	Greenriver.
Do	Renton.	Grey Bull	Meeteetse.
Methow	Peteros.	Laramie	Uva.
Naches	North Yakima.	Little Laramie	Haley's ranch, Laramie.
Palouse	Hooper.	Do	May's ranch, Hatton.
Salmon	Malott.	Middle Crow Creek	Hecla.
Sinlahekin Creek	Loomis.	North Platte	Guernsey.
Skykomish (South Fork).	Index.	Do	Saratoga.
Snoqualmie	Snoqualmie.	Piney Creek	Kearney.
Spokane	Spokane.	Prairie Dog Ditch	Sands's ranch.
Stilaguamish	Robe.	Shoshone	Cody.
Tieton	North Yakima.	Do	Marquette.
White	Buckley.	Shoshone (South Fork.	Do.
Yakima	Kiona.	Sweetwater	Devilsgate.
Do	Union Gap.	Tongue	Dayton.

Division of Hydrology.

This division, organized in January, 1903, results from the gradual increase and differentiation of investigations of underground waters as reached by deep wells. The appropriation acts have contained, since 1894, authority for determining the water supply of the United States and for investigating underground currents and artesian wells. Facts concerning artesian and other deep wells have been collected and systematically arranged, and a number of papers have been published in the Water-Supply, Bulletin, and Annual Report series, and data have been procured for use in geologic folios. The operations are very closely connected with those of the geologists, and the facts obtained concerning the occurrence and movement of water under ground can be interpreted only by full knowledge of geologic structure. Various local geologists and students have been employed in this work and the investigations have been widely extended. A large correspondence has grown up, begun for the purpose of obtaining information and swelled by numerous requests for facts made by drillers or citizens interested in securing an underground supply for domestic, municipal, or manufacturing purposes.

In order to systematize this work and permit of its being developed and specialized, investigations relating to wells and underground waters were segregated from the division of hydrography and grouped into a distinct organization known as the division of hydro-geology or hydrology. The work of the division includes the gathering, filing, and publication of statistical information relating to the occurrence of water in artesian and other deep wells; the gathering and publication of data pertaining to springs; the investigation of the geologic occurrence, from both stratigraphic and structural standpoints, of underground waters and springs; a study of the laws governing the occurrence and flow of subterranean waters and springs, including the investigation of variations due to tidal, temperature, and barometric fluctuations; direct measurements of rate of underflow; detailed

surveys of regions in which water problems are of great importance and urgency, and the publication of reports on irrigation, city water supplies, and other important uses of underground waters.

The division of hydrology is divided into two sections, eastern and western, the first embracing the States east of the Mississippi and those bordering that river on the west, and the second including the so-called reclamation States and Territories. The chief hydrographer acts as chief of the division, but the two sections have been placed in charge of geologists, Mr. N. H. Darton being assigned to the western section and Mr. M. L. Fuller to the eastern.

In addition to his other duties, Mr. Fuller has charge of the card catalogues of deep wells, springs, and city water systems of the entire country.

Because of the intimate relations of the work of the division of hydrology to that of the geologic branch, arising from the geologic nature of many of the investigations and the consequent employment of numerous geologists by the former, it early became desirable that arrangements for cooperation be made. The following plan bearing upon the relation of the division of geology and paleontology to that of hydrology was accordingly prepared, and was approved by the Director on May 26, 1903.

1. Members of the division of hydrology engaged in a geologic study of underground waters should be instructed to confer, with respect to the scientific aspects of their work, with geologists in charge of sections in the division of geology, and it should be understood that these section chiefs have the same authority, with relation to scientific questions, over geologists in the division of hydrology, that they have over geologists in the division of geology.

2. Members of the division of hydrology should be instructed to collect and prepare for publication, incidentally to their work on underground waters, as many purely geologic data as possible, particularly in little

known regions where such data are required for the preparation of the geologic map of the United States. With this end in view they should confer with the geologist in charge of areal geology.

3. Members of the division of geology have been instructed to collect data relating to the occurrence of underground waters in the region in which they are working, and to prepare, for geologic folios, sheets showing the conditions of its occurrence in regions where the underground waters are of great importance.

4. Instructions relating to the scientific aspects of work in the division of hydrology should be submitted to the division of geology for approval, in order that unnecessary duplication of geologic work may be avoided and that proper coordination between the work undertaken by the two divisions may be secured.

5. Reports resulting from the work of geologists in the division of hydrology should be submitted to the division of geology for critical reading and recommendation before publication.

6. All matters pertaining to administration, such as monthly reports, accounts, etc., should be confined to the division with which the geologist is connected.

EASTERN SECTION OF HYDROLOGY.

Under the direction of the chief hydrographer, Mr. M. L. Fuller took charge of the work of this section on January 1, 1903. At this date the only work relating to underground waters under way in the area covered by the section was that conducted by Mr. A. C. Veatch in Louisiana and Arkansas and by Mr. L. C. Johnson in Mississippi. Immediately on assuming charge, Mr. Fuller entered into communication, either by personal conference or by correspondence, with State or other geologists throughout the section, and preliminary arrangements were made for beginning work in twenty-one States, viz: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Georgia, Florida, Minnesota, Michigan, Wisconsin, Iowa, Missouri, Arkansas,

Kentucky, Tennessee, Louisiana, Mississippi, and Alabama. The immediate preparation of detailed reports was arranged for in Minnesota and Louisiana. In May Mr. Fuller visited most of the States mentioned and completed the arrangements and outlined plans for the work of the summer.

In the office, after consultation with the librarian, chief photographer, and several geologists, card catalogue systems were devised by Mr. Fuller for filing and rendering easily available the well records, spring data, and city water-supply information. Special printed cards were prepared for each class of information, the cards being so devised that they can be submitted directly to the printer as copy for reports. The record cards, except those which are confidential, will be loaned to members of the Survey for use in their work whenever needed. An arrangement was also made by Mr. Fuller with Mr. F. B. Weeks whereby a bibliography covering hydrography and hydrology, similar to those which have proved of so much value to geologists, will be prepared annually. Arrangements were also made whereby cooperation of both geologists and topographers was secured in furnishing information of new developments and such facts relating to the occurrence of underground waters as come to their attention.

As a basis for future field work a preliminary correspondence with postmasters and others was undertaken by means of printed requests for the addresses of drillers, well owners, etc., and for information relating to town water supplies, springs, and wells. A considerable amount of valuable information was obtained from several different States.

WORK BY STATES.

Maine.—The principal work in this State was placed in charge of Prof. W. S. Bayley, assistant geologist, who was assisted by Messrs. W. C. Washburn and L. G. Lord. The work consisted in the collection of data bearing on deep and shallow wells, springs, and city and town water supplies. Letters of inquiry were sent to postmasters,

water companies, mayors of cities, summer hotels, leading manufacturing companies, and well drillers throughout the State, and the books of the State board of health were consulted and more than 600 sanitary analyses obtained. Lists of the commercial springs and lists showing the source of water supply of every city and town of the State are in preparation, this and other information being compiled in card catalogue form. One trip was made along the coast and islands, where the water problems are especially important, and much valuable geologic information bearing upon water supplies was obtained. It is expected that important additions to the present meager knowledge of the age, structure, and relation to underground water supplies of the rocks of the State will be made.

In addition to the work of Professor Bayley an arrangement was made with Mr. G. O. Smith, geologist, to investigate in detail the water problems of the Blue Hill quadrangle, in connection with his geologic examination of the area for the geologic branch of the Survey.

New Hampshire.—In addition to his work in mining geology in the West, Mr. J. M. Boutwell, assistant geologist, undertook the work of gathering data in regard to springs and underground waters of New Hampshire. Correspondence was carried on with postmasters, various officials, and geologists and others throughout the State, and the foundations were laid for a thorough investigation. Several problems of consequence were encountered, including the important one of supplies for summer residents along the coast, and investigations looking to their solution were begun.

Vermont.—Prof. George H. Perkins, State geologist, began about April 1 the work of gathering information relating to the occurrence, composition, uses, and value of underground waters and springs. Many of the more important localities were visited and valuable information was secured. A report will be prepared giving the results of his work.

Massachusetts and Rhode Island.—This district, which was placed in charge of Prof. W. O. Crosby, of Boston, early in March, was later further subdivided, the northern, central, and western portions of Massachusetts being assigned to Mr. Laurence La Forge, of Cambridge, while the Boston Basin, the southeastern portion of Massachusetts, and the State of Rhode Island were placed in direct charge of Professor Crosby. Active correspondence with drillers and others has been begun and a number of short field trips have been made, the results of which will appear in a progress report at the end of the year.

Connecticut.—The work in Connecticut was placed in charge of Prof. H. E. Gregory, of New Haven, on April 1. Portions of April, May, and June were devoted to correspondence with well drillers and others having information relating to wells and springs, and the data thus obtained was used as a guide in outlining plans for field work during the present summer.

An interesting scientific development is the discovery of radio-active gases in the waters of Indian Rock Spring at New Milford (temperature of water 45°) and at Lake Whitney, New Haven. It is thought to be due to the action of some element that is as yet unknown.

New York.—The work in New York includes two distinct lines of investigation: (1) The investigation of the geology and water resources of Long Island, and (2) the investigation of the spring waters of the State.

Plans for the work on Long Island were made about February 15, after consultation with the commission on additional water supply for New York City, with whom an arrangement for cooperation was made. The investigation was divided into several branches, as follows: (1) Geologic investigations, (2) water-supply investigations, and (3) laboratory investigations.

The geologic investigations on Long Island embrace the detailed mapping and study of the various formations of the island, including the examination of samples of borings

from about a hundred test wells sunk by the commission mentioned and from a still larger number of samples and records obtained from outside drillers. The areal geology was subdivided into Cretaceous geology, in charge of Mr. Arthur Hollick, and Pleistocene geology, in charge of Mr. M. L. Fuller, assisted by Mr. D. W. Johnson. The underground data, including those from borings and well records, were obtained by Mr. A. C. Veatch, assisted by Messrs. Isaiah Bowman, F. D. Rathbun, and Francis Whitney. Several important geologic discoveries were made, including (1) large pre-Pleistocene (Cretaceous?) areas beneath and south of the outer moraine in West Hills, in southern Huntington Township; (2) quartz gravels with rotted granitic material and with an old topography, lying between and beneath the moraines near Old Westbury; (3) the proof of the extension of the Manhasset gravels beneath the moraine and outwash plains at Bethpage and elsewhere; (4) the probable correlation of the Far Rockaway with the Manhasset gravels; (5) a buried drift sheet at a depth of nearly 200 feet near Brooklyn; and (6) proof of the absence of the supposed uniform Chesapeake "clay floor" beneath the outwash plains.

The investigations bearing more directly upon the water resources of Long Island were also placed in charge of Mr. Veatch, who was assisted by Messrs. Bowman, Rathbun, and Whitney. The work includes (1) a study of the stratigraphy with special reference to water supplies; (2) the investigation of seasonal, tidal, thermal, and barometric fluctuations of wells; (3) the investigation of blowing wells; (4) the systematic collection of information relating to the waterworks systems of the island; (5) volumetric measurement of springs; and (6) collection of data bearing upon the occurrence, available quantity, rate of flow, etc., of the ground water. In the latter line of investigation direct measurements of flow have been successfully made by means of electrical apparatus invented and operated by Prof. Charles S. Slichter. Professor Slichter has also made a large number of chemical determinations upon the waters of the island.

The laboratory work in charge of Prof. W. O. Crosby is being conducted in the laboratories of the Massachusetts Institute of Technology, and consists of the determination of (1) the size and angularity of grains and fragments; (2) the geologic composition of the samples; (3) their probable age and mode of deposition; (4) their porosity, or water-holding capacity; and (5) the rate of delivery under known head.

The second main division of the work in New York, that relating to the springs of the State, was placed in charge of Mr. F. B. Weeks, who began field work in the latter part of June, after conducting an energetic correspondence during the month previous. He will prepare a report upon the occurrence, composition, uses, etc., of the spring waters of the entire State. Attention will also be given by Mr. Weeks, while in the field, to the deep wells of the State, with a view of detailed investigations in the future.

New Jersey.—A plan of cooperation was arranged with Mr. H. B. Kümmel, State geologist, whereby Mr. G. N. Knapp will complete the field work on underground waters at the expense of the State survey and then prepare a detailed report on the same at the expense of the National Survey. Mr. Knapp spent a month or more in the field in pursuance of this plan during the latter part of the fiscal year.

Georgia.—The work in Georgia consists in bringing the information relating to artesian wells up to date, the investigation of the composition of the waters, the study of the important springs of the State, the study of the uses of the underground water resources, and the determination of the prospects in untried areas. The field work along these lines was rapidly pushed by Mr. S. W. McCallie, assistant State geologist, assisted at times by Mr. J. C. Conn. Mr. McCallie will prepare an extended report on the underground water resources of Georgia and their economic uses.

An investigation as to the possibility of the pollution of wells and springs at Quitman and adjoining regions

through the emptying of sewage into an underground stream in the limestone is under way.

Florida.—Besides his office duties in connection with the organization and administration of the work of the eastern section, Mr. M. L. Fuller carried on an extended correspondence with postmasters, well owners, hotel proprietors, well drillers, and others in Florida, with the view of obtaining information relating to water supplies which will serve as a basis for field work soon to be undertaken.

Minnesota.—In connection with his work for the University of Minnesota and for the State geological survey, Prof. C. W. Hall gathered a large amount of information relating to both the surface and the underground water resources of the State. An arrangement has been made whereby this will be incorporated in a detailed report to be submitted at the close of the fiscal year.

Wisconsin.—The investigation in this State, upon which work has already been begun by Mr. A. R. Shultz, includes a systematic field examination of the artesian areas, the areas of deep but nonflowing rock wells, the areas of drift wells, and a study of the springs of the State. The Upper Peninsula of Michigan and northeastern Illinois will also be covered by Mr. Shultz. On the completion of the work a detailed report will be prepared.

Michigan.—The work in this State includes the systematic collection of data relating to deep wells and springs, both by correspondence and by field work. The investigations were undertaken by Mr. W. F. Cooper, under the general supervision of Mr. A. C. Lane, State geologist. Correspondence was begun about April 1 and continued until late in June, when Mr. Cooper took up the field investigation of the geologic and topographic relations of the water supplies, special attention being paid to the Napoleon sandstone.

Iowa.—The investigation of underground waters in this State was placed in charge of Prof. W. H. Norton, who has had long experience in this line of work, for the State survey. Much information, including data relating to the

location, size, and depth of the wells, strata penetrated, water-bearing horizons, volume, composition, head, uses of the water, etc., was obtained. Temperature, interference of wells, diminution of the deep flows, phenomena of the artesian wells of the drift, and the numerous common wells and springs will also receive attention. Valuable additions to the information relating to wells and springs are expected to result from the studies of the various parties of the Iowa geological survey now in the field. This and Professor Norton's personal observations will be incorporated in the report which will be prepared for the Survey.

Missouri.—Work was begun in March by Prof. E. M. Shepard, of Springfield, who devoted his vacations and other spare time to the work of conducting correspondence in relation to deep wells, springs, and town water supplies. A number of field examinations were also made in important artesian and spring districts, and early in June a detailed field study of spring and underground water problems was begun. Among the results so far accomplished are (1) the discovery of new artesian areas and (2) the discovery of a definite relation between ore horizons and springs in the southwestern portion of the State. Promising investigations are under way upon (1) the relative temperatures of cavern and surface springs at similar horizons, (2) the fixing of the horizons of water-bearing beds, (3) the remarkable development of caves and sinks by underground drainage, (4) surface modifications due to underground drainage, (5) the origin of the sulpho-saline waters of northern Missouri, (6) the quantitative determination of the more deleterious constituents of the waters, (7) the general origin, flow, and temperatures of underground waters, and (8) their economic uses.

Arkansas.—Work upon the geology of northern Louisiana and southern Arkansas, with special reference to its relations to underground water resources, was taken up by Mr. A. C. Veatch on August 1, 1902, and continued until March 1, 1903. The work in the Louisiana-Arkansas

area involved a careful study of the stratigraphy of the region, and the collection of about 1,200 well records. With the help of temporary field assistants about 100 miles of reconnaissance levels were run, connecting wells with surveys and railroad levels, and furnishing data for dip calculations. This work has thrown much light on the structure of the region and developed many new points of economic interest in connection with the water supply. By correspondence numerous data have been collected regarding that part of eastern Texas which is south of the Cretaceous-Tertiary contact.

After the transfer of Mr. Veatch the services of Prof. A. H. Purdue, of Fayetteville, Ark., were secured to continue investigations in the portion of the State lying north of the Arkansas River. Correspondence covering both the Paleozoic and the Tertiary areas was first conducted with drillers and others familiar with the deep wells or underground water problems, on the completion of which field work was begun along the Tertiary-Paleozoic contact from Little Rock northeastward to the borders of the State. It is proposed to map the contact, to determine the nature of the Tertiary overlap, to fix the horizons of the water-bearing beds, to outline the catchment area, and to investigate the economic possibilities of the water supplies. It is expected that the work will be of value in determining the most available water horizons for towns and cities, and will hasten the use of underground waters for the irrigation of rice and the consequent development of its culture into an important industry.

Louisiana.—The work of Mr. A. C. Veatch in this State has been mentioned under Arkansas. In addition to this work, important investigations relating to underground waters have been made by Prof. G. D. Harris, State geologist, who is now preparing a report on the geology of the State and its relation to the occurrence and economic uses of the underground water supplies.

Kentucky and Tennessee.—The work in this State was placed in charge of Mr. L. C. Glenn, of Nashville, Tenn., in March, and correspondence was at once begun with

well drillers and others. Field work was begun in June in the portions of the Mississippi embayment area included in these States. The investigations will include a systematic study of the stratigraphy and structure of the Tertiary rocks, their relations to the adjoining Paleozoic rocks, and a detailed investigation of the water problems, including the determination of water horizons, catchment areas, and the amount, quality, and uses of the underground waters.

Alabama and Mississippi.—Prof. E. A. Smith, State geologist of Alabama, who was already conducting work in these States, continued in charge on the organization of the eastern section. Professor Smith was assisted by Mr. L. C. Johnson in Mississippi and by Messrs. J. A. Anderson, R. S. Hodges, and B. F. Lovelace, members of the State survey, in Alabama. A report embodying the known facts relating to the underground waters of Alabama was prepared and submitted by Professor Smith in 1902. During the last spring much additional information was obtained by Professor Smith and assistants in Alabama and by Mr. Johnson in Mississippi.

Special attention was given to the tracing of the "Burhstone" formation and other horizon markers, and to the determination of the stratigraphy of the two States, including the determination of the position of the Grand Gulf formation. The stratigraphic positions of the principal water-bearing formations have been fixed and their areas determined as far as possible. The depth at which water may be reached in northeastern Mississippi, along the "Burhstone" outcrop, and in the Mississippi delta and coast regions, can now be predicted with reasonable accuracy. The systematic chemical examination of the waters of the springs and artesian and other deep wells has resulted in bringing to notice a number of important mineral waters and in the beginning of a bottling industry.

WESTERN SECTION OF HYDROLOGY.

By order of the Director, dated May 18, 1903, Mr. N. H. Darton was transferred to the hydrographic branch of

the Survey and placed in charge of the western section of hydrology, under the direction of the chief hydrographer.

For several seasons Mr. Darton has been devoting his attention to problems of underground waters, mainly in the West, and for some time past had been engaged in the preparation of a review of the geology and water prospects of the central Great Plains. In the new section it is proposed to extend this work into other portions of the West, and, by assistants and State cooperation, make investigations of underground water supplies in all of the so-called reclamation States and Texas.

There were assigned to the section Messrs. W. C. Mendenhall and G. B. Richardson, assistant geologists of the Survey, and Messrs. Willis T. Lee and C. A. Fisher were engaged for service as field assistants. Arrangements were made for certain special examinations in the West and for cooperation with some of the State and Territorial geologists. A large amount of information which has been obtained through schedules and other means in the past was transferred to Mr. Fuller for preservation in card-catalogue form.

REPORT ON CENTRAL GREAT PLAINS.

Besides the various investigations of the section, Mr. Darton continued the preparation of his report on the geology and underground water resources of the central Great Plains, in order to complete it for early publication. In this report there is presented all available information regarding the stratigraphy and geologic structure in the greater part of South Dakota, Nebraska, Kansas, eastern Colorado, and eastern Wyoming. It includes the results of several years of field work by Mr. Darton and his assistants and a résumé of published information. A thorough canvass has been made to obtain data respecting deep borings which have been made in the region, and the results and bearing of these have been reviewed. This is particularly important in connection with the proposition to sink deep wells in the Plains area to ascertain the underground water conditions in unexplored dis-

tricts, and possibly in some areas to obtain underground waters for the reclamation of arid lands. The principal illustrations of the report consist of two maps, one showing the geology and the other showing the location of all deep wells, the area underlain by Dakota sandstone, and the depths to that formation in those portions of the area of which the structure is ascertained.

WORK BY STATES AND TERRITORIES.

Arizona.—Owing to the very great usefulness of underground waters which have been developed in the Salt River and other valleys in south-central Arizona, an investigation has been begun to ascertain the extent of the area in which underground waters are available, the geologic conditions under which they occur, the volume of water likely to be obtainable, and the conditions under which the waters can be utilized to the best advantage.

Mr. Willis T. Lee, assistant geologist, was detailed to this investigation and spent May and June in an examination of portions of the area. He made detailed studies of the region about Mesa and Phœnix and visited the Tucson and Benson districts. Important features of the work were the collection of all available data relating to wells which have been sunk, and the careful watching of variations in the water level at localities where the waters are being extensively utilized.

California.—Systematic studies of the occurrence and movement of underground waters in California were conducted by Mr. Homer Hamlin, under the general direction of Mr. J. B. Lippincott. Field tests were made of the apparatus devised by Prof. Charles S. Slichter for measuring the rate of movement of underground waters. One of the most difficult matters in connection with such investigations has been the sinking of wells in which to make the tests. It has been found necessary to sink a group of wells, one of these being treated with ammonium chloride or other electrolyte, the others being arranged in a semicircle near the first well. The rate of movement

of the electrolyte from the upper to the lower wells is measured by suitably arranged self-recording electrical devices. The sinking of these wells rapidly and economically in beds of coarse gravel and small bowlders was at first found to be almost impossible; but Mr. Hamlin, with the assistance of experienced drillers, succeeded in perfecting a device which puts down such wells with great rapidity.

The well-sinking apparatus used by Mr. Hamlin is operated by a small gasoline engine. Thick wall casing about 3½ inches in external diameter is provided with strong taper joints and without collar or projection. The lower end is armed with a steel tooth shoe, and the upper end is protected by a driving head. The casing is driven and given a rotating motion at the same time. Inside is a chopping bit, with water jet operated continuously. The casing is rotated and driven, the chopping bit inside, with its washing apparatus, is operated, and through the combination of these motions the casing is forced rapidly downward into coarse gravel and among small bowlders, these being either broken or forced aside. One man attending to the gasoline engine keeps in action all of these various operations, while a helper is at hand to assist in the adjusting of the apparatus as the casing is forced down.

By this method wells have been sunk successfully and economically in the gravel- and bowlder-filled channel of Los Angeles River, and by means of these it has been possible to make measurements of the rate and direction of percolation of the water at various depths in this channel. The method of automatically recording, as devised by Professor Slichter, has been found to be successful, and light has been cast upon the obscure phenomena of the movement of waters under ground.

In addition to this work Mr. Hamlin conducted observations of the depth to ground water and the amount of water obtained from under ground in important areas of southern California, particularly in the country between and south of San Bernardino and Los Angeles. The

information thus obtained will supplement that published in Water-Supply Papers Nos. 59 and 60, and will be presented in similar form.

Colorado.—The portion of Colorado lying east of the Rocky Mountain front is covered by Mr. Darton's investigation of the central Great Plains.

Kansas.—In the preparation of the report on the central Great Plains an endeavor has been made to obtain all available information regarding deep borings in this State, especially those which penetrated the Dakota sandstone. In the latter part of June Mr. C. A. Fisher proceeded to the northwestern portion of the State to investigate the deep borings which are in progress for oil, and to arrange for obtaining any data which they may afford regarding underground water prospects.

Nebraska.—A special investigation of the geologic structure and the extent of the artesian water basin in the northeastern portion of this State was begun by Prof. G. E. Condra, of the State University. There is much demand for information regarding the limits of the artesian basin in this section, and doubtless an investigation of its geology would throw light on relations in the region southward.

New Mexico.—Negotiations are in progress for cooperative work with the Territorial geologist for an investigation of the underground water resources in the south-central portion of the Territory.

North Dakota.—The late C. M. Hall, professor of geology at the State Agricultural College, was engaged for several seasons in investigating the underground waters and geology of the Red River Valley. At the time of his death he had completed the examination of an area of considerable size, comprising the Casselton and Fargo quadrangles. Arrangements have been made with Prof. D. E. Willard to complete the manuscripts of this investigation and to continue field work during the coming year. Arrangements have been made with Prof. F. A. Wilder, State geologist, for cooperative work in the western portion of the State, mainly for the examination of

lignite deposits which may serve for fuel in pumping surface waters into reservoirs and ditches for irrigation. The large amount of this cheap fuel available promises to be serviceable in this way, and the investigation has aroused much local interest.

Oklahoma.—For several months Prof. C. N. Gould has been collecting data relating to underground waters of the Territory. Early in the summer a party was organized under Professor Gould's direction to study the water resources of the district underlain by the Red Beds, a region in which water is greatly needed, but in which numerous borings have been unsuccessful in obtaining satisfactory supplies.

Oregon.—A party was organized, to be conducted by Prof. I. C. Russell, to investigate the geology and water resources of eastern Oregon, in continuation of his investigations of previous seasons.

South Dakota.—There is in preparation a report on the geology and underground waters of a portion of the James River Valley, by Prof. J. E. Todd and the late Prof. C. M. Hall, which will soon be ready for publication. Arrangements have been made for a continuation of this work by Professor Todd, especially with the view of ascertaining whether the artesian water supply is being diminished by the large number of wells which are drawing upon it. Prof. C. C. O'Harra made a short field study of the region north of the Black Hills to ascertain some of the geologic conditions bearing on prospects for artesian water.

Texas.—Jointly with the State mineral survey an investigation is in progress in western Texas, by Mr. George B. Richardson, to ascertain the prospects for water for deep wells in El Paso County and a portion of Reeves County. The State holds a large amount of school land in this district, and it is believed that, if there are prospects for obtaining successful wells, these lands can be made a source of income. The determination of the conditions in this area will throw light upon the adjoining districts in other portions of Texas and New Mexico.

Washington.—Mr. F. C. Calkins, one of the assistant geologists of the Survey, has in preparation a report on the geology and water resources of the Yakima district in Washington, which will soon be ready for publication. It was prepared by Mr. Calkins incidentally to his regular geologic work in the State. Mr. Henry Landes, State geologist, has been engaged to obtain all available information regarding deep borings and other sources of underground water supply in the State for tabulation and to serve as a basis for further investigations of special artesian basins.

Wyoming.—Last autumn a special canvass was made to obtain data respecting all attempts to obtain underground waters in the eastern portion of this State, the results of which will be set forth in Mr. Darton's report on the central Great Plains.

Division of Hydro-Economics.

Under this heading have been included investigations into quality of water, with special reference to the effect of this upon the industrial development, and the value of various sources of supply for domestic use or other industrial purposes. The study of the economic value of water and of its fitness for use in the various lines of special water-supply development is more important than has generally been believed. Enormous amounts of money have been wasted because the adaptability of water in many particular lines has not been properly determined, and little or no information is to be had concerning this matter in the greater part of the United States. It frequently happens that an ample supply of water can be had from a river, lake, or well, but the mineral impurities are of such a character as to limit or prevent its use, necessitating large expenditure to procure water elsewhere, or, in some cases, the failure or suspension of the industry.

Or, again, it frequently happens that a source of supply originally of excellent quality has become contaminated by sewage or other organic matter and can not be used without filtration or other treatment, or has become so

polluted as to cause vast losses through sickness, death, destruction of ice crop and of fisheries, and depreciation of realty values. Extended discussions of this subject have been published in Water-Supply Papers No. 72 and No. 79. In short, the quantity of water, while important, must be joined with considerations of its quality in any determination of the water supply of the country or in the preparation of reports of the best methods of utilizing water resources.

The need of a systematic investigation of the quality of surface and ground waters in the United States has resulted in the establishment of the hydro-economic division and the employment of Mr. Marshall O. Leighton for the purpose of devoting his time and energies to this subject. The plans which have been made and followed by him up to the present include:

The collection of all analytical data and the arrangement and classification of the same for ready reference and use. These analyses include principally the inorganic determinations, made for the purpose of showing the proportion of various harmful salts, and the ordinary sanitary analyses, which show the amount of organic matter and its state of oxidation, together with various other determinations, such as color, turbidity, and hardness. Determinations of the former class are of especial importance to all interests involving the use of steam boilers, such as railroads and stationary steam-power plants, and to manufacturers who are obliged to use care in the selection of waters which will not be detrimental to manufactured products that are the result of finely balanced chemical processes. The latter series of analyses finds important use in the above-mentioned departments of industry, and, in addition, is of enormous practical benefit to municipalities and institutions seeking domestic water supplies.

The second feature of hydro-economic work involves the extension of the data above described by means of cooperative relations with numerous university and State laboratories. In this manner various important water

problems have been taken up in different parts of the country, a few of which are nearing completion.

Of exceedingly practical value is the investigation which has been begun with reference to the effect of different industrial wastes upon the streams of the country. It was found that the damage done to riparian rights and allied water values by certain kinds of trade refuse amounts to many millions of dollars; this, too, notwithstanding the fact that in the majority of cases such destruction is needless and easily prevented. Of singular interest is the fact that there is usually much valuable material in industrial wastes which might be economically recovered.

The most important work of the hydro-economic division is the investigation of methods of rapid field analysis. The usual methods of analysis of water by chemical and bacteriological means are expensive and slow. At best only a few samples can be analyzed, and where conditions are changing rapidly from time to time and place to place a few samples may not represent the prevailing conditions. It is far more important to make a large number of comparatively rough determinations, and average these, than to depend upon a few analyses made with great refinement, and there is no doubt that such an average represents more truly the exact condition of the water.

In addition to the work performed by Mr. Leighton in connection with the hydro-economic division, he established and maintained river stations in the Mississippi Valley, this work being done in connection with the initiation and practical testing of methods of examination of the quality of water. In this work Mr. Leighton was assisted by a number of chemists and specialists on water values and sanitary subjects, some of whom are named below.

Prof. F. C. Robinson, of Bowdoin College, Brunswick, Me., carried on analytical work on the Androscoggin and Penobscot rivers, for the purpose of determining their value as sources of domestic and industrial water supply,

Mr. Edwin B. Goodell, of Montclair, N. J., undertook the preparation of a report on existing State statutes with reference to river pollution, and a compilation of court decisions bearing on this subject. In collaboration with him Dr. John L. Leal, of Paterson, N. J., undertook the preparation of a second section on the economical status of river pollution with respect to the municipal water supplies of the United States. A third section of the same report is being prepared by Mr. Harold W. Cole, of New York City, on the economical aspects of river and lake pollution with reference to damage to ice supplies.

Prof. Chase Palmer, of Central University of Kentucky, Danville, Ky., undertook the periodical examination of waters at the heads of the Cumberland, Green, and Kentucky river systems and at various selected points along the Kentucky River in that State.

Valuable advice and assistance and the contribution of many series of analyses of boiler waters were received from the following officials of railroads in the United States:

Dr. Charles B. Dudley, Pennsylvania Railroad Company, Altoona, Pa.

Mr. H. E. Smith, Lake Shore and Michigan Southern Railway, Collinwood, Ohio.

Mr. W. A. Powers, Atchison, Topeka and Santa Fe System, Topeka, Kans.

Mr. David Van Alstyne, Chicago Great Western Railway, St. Paul, Minn.

Mr. M. H. Wickhorst, Chicago, Burlington and Quincy Railroad, Aurora, Ill.

Mr. J. R. Onderdonk, Baltimore and Ohio Railroad Company, Baltimore, Md.

Mr. George N. Prentiss, Chicago, Milwaukee and St. Paul Railway Company, West Milwaukee, Wis.

Mr. G. M. Davidson, Chicago and Northwestern Railway Company, Chicago, Ill.

Mr. R. H. Mahon, New York Central and Hudson River Railroad Company, West Albany, N. Y.

Mr. F. O. Bunnell, Chicago, Rock Island and Pacific Railway, Chicago, Ill.

Dr. J. N. Hurty, Cleveland, Cincinnati, Chicago and St. Louis Railway, Indianapolis, Ind.

Mr. H. G. Kelley, Minneapolis and St. Louis Railroad Company, Minneapolis, Minn.

Mr. A. W. Johnston, New York, Chicago and St. Louis Railroad Company, Cleveland, Ohio.

Mr. Robert Job, Philadelphia and Reading Railway Company, Reading, Pa.

Mr. R. P. Sanderson, Seaboard Air Line Railway, Portsmouth, Va.

Mr. H. Stillman, Southern Pacific Company, Sacramento, Cal.

Among others to whom acknowledgments are due for advice and assistance are Robert Spurr Weston, George W. Fuller, Allen Hazen, New York City; Dr. Charles O. Probst, Columbus, Ohio; F. A. W. Davis, Indianapolis,

Ind.; Dr. Arthur R. Reynolds, Chicago, Ill.; Prof. Edwin O. Jordon, Chicago, Ill.; Dr. Benjamin Lee, Philadelphia, Pa.; Henry A. Pressey, Washington, D. C.; Prof. Edward Hart, Easton, Pa.; James M. Caird, Troy, N. Y.; Prof. A. W. Palmer, Champaign, Ill.; Dr. Armand Ravold, St. Louis, Mo.; Mr. George G. Earl, New Orleans, La., and Dr. F. F. Westbrook, Minneapolis, Minn.

Reclamation Service.

The reclamation law was signed by the President on June 17, 1902. This commits to the care of the Secretary of the Interior the proceeds from the disposal of public lands in the Western States and Territories. The funds, amounting to from $3,000,000 to $4,000,000 a year, are to be utilized in surveys and examinations and in the construction of works for reclaiming arid land. Preliminary investigations of the extent to which these arid lands can be reclaimed by irrigation have been carried on by the Geological Survey for many years, as stated in the Twenty-third Annual Report, pages 11–15. For this reason the Secretary of the Interior intrusted to the Director of the Geological Survey the initiation of work under this law. Plans were approved at the beginning of the fiscal year, and the various engineers who had previously been engaged in these investigations were provided with added facilities for extending the work and carrying on to construction the projects whose feasibility had been indicated by past work.

For economy and efficiency of organization it was decided to make the reclamation service one of the divisions of the hydrographic branch, thus taking advantage of the rules, regulations, and precedents established by the Geological Survey. This permitted a continuity of growth along lines already found successful. Additional men were obtained from lists certified by the Civil Service Commission, and from time to time examinations were widely advertised and subsequently held, making available a large number of experienced men and young, well-educated assistants.

The organization and general conduct of the work were intrusted to Mr. F. H. Newell, as head of the hydrographic branch and chief engineer of the reclamation service. Work in the field relating essentially to engineering estimates and operations was intrusted to Mr. Arthur P. Davis, supervising engineer. The conduct of field parties in making preliminary surveys for diversion lines, reservoirs, etc., and outlining of irrigable lands, was given to Mr. Charles H. Fitch, diversion engineer. In addition, from time to time consulting engineers were employed and the results of various surveys and examinations were submitted to these engineers, constituting boards of review. The reports of these boards, transmitted to the chief engineer, serve as the basis for further surveys or for recommendations to the Secretary of the Interior.

The engineers above enumerated and various specialists form an executive and consulting staff to advise the Director of the Geological Survey, and through him the Secretary of the Interior, on important matters and to carry these out when properly authorized. In addition there are resident or district engineers, having direct and immediate charge of work in each of the States and Territories. These men are responsible to the chief engineer, and their conclusions or recommendations are submitted, when necessary, to the consulting engineers or boards designated by the chief engineer.

In the following paragraphs brief mention is made of the personnel and operations in the various States and Territories. More complete information will be found in the First Annual Report of the Reclamation Service, transmitted to Congress in December, 1902, and in the Second Annual Report, to be transmitted to Congress early in December, 1903.

Arizona.—Surveys were begun on various feasible projects for reclaiming arid land, the principal of these being on the Salt River near the mouth of Tonto Creek, on the Gila below San Carlos, and along the Colorado from Needles to Yuma. The results of these surveys and

examinations will be submitted to the Secretary of the Interior for decision as to construction of reservoirs, canals, and other hydraulic works.

On the Salt River plans and estimates were made for a large dam to store the flood waters; also for cement works to manufacture the cement needed in the construction of the dam, and for an electric power plant for developing power to be used in connection with construction and for pumping water for irrigation in the Salt River Valley. Detailed mapping was also begun in the canyon of the Salt River and extending easterly to and beyond Phœnix and southerly to the vicinity of Florence and the Sacaton Indian Reservation. This map shows, in 10-foot contours, all elevations of the surface, roads, houses, irrigating canals and ditches, wells, and all other improvements. It will serve as a basis upon which to indicate the character of the land and the ownership.

On the Gila near San Carlos diamond-drill borings were made to ascertain depths to bed rock and to obtain information upon which to base more complete plans and estimates of the cost of storage of the floods of this stream. Observations of river flow and of sediment were made, and other facts bearing on the problem of water conservation were ascertained. The irrigable lands are to be mapped as noted above in connection with the systematic mapping of the Salt River Valley.

The reclamation of lands along the Colorado is one of the great problems of future development. Detailed contour maps have been made of the lands along the river, showing the slope of these and affording data upon which to base preliminary estimates for alternative plans of reclamation. In all, very nearly 400 miles of river have been carefully studied, and work has been begun upon the determination of the depth to bed rock at the most important dam sites.

Systematic measurements of the Salt, Gila, and Colorado rivers were carried on, and data were obtained which will be of use in considering the plans of the reclamation service. Systematic study of the underground waters of

the Salt River Valley was also begun with a view to the full development of these, and a reconnaissance of the artesian conditions in the vicinity of Benson and Tucson was made.

California.—The principal work in this State was done in connection with the utilization of the waters of the Colorado for the reclamation of arid lands along that stream, those on the east side being in the Territory of Arizona and those on the west side in the State of California. In addition to the detailed mapping of irrigable lands and dam sites, diamond-drill borings were begun at the most northerly of the possible reservoir sites, about 40 miles above Needles, near what is known as Bulls Head.

Headquarters for the Colorado River work were established in October, 1902, at Needles, Cal., the work being under general charge of Mr. J. B. Lippincott, and the immediate direction being intrusted to Mr. E. T. Perkins, assisted by Mr. John T. Whistler and other engineers. Various field parties were organized, the work of mapping and studying the opportunities for reclamation being so distributed as to obtain the most complete information possible concerning the river during the period of low water. Explorations were made above Bulls Head, and detailed surveys of the river banks both above and below this point were made by Messrs. John E. Rockhold, Joseph A. Sargent, Goyne Drummond, L. M. Lawson, and other assistant engineers. The attempt was made to instruct as large a number of young assistants as possible, in order that their services might be available elsewhere during the summer of 1903.

While the surveys and examinations along the Colorado were being conducted from Needles, Cal., as a base of supplies, similar mapping was accomplished through cooperation with the Pacific division of topography, under the direction of the late Mr. Richard U. Goode. Plans were made for completing certain quadrangles on the usual scale, approximately 1½ inches to a mile, or 1:90,000. In the vicinity of the river, however, and upon the lands

lying at an altitude of 150 feet or less above the river, more detailed maps were made, on the scale of 2 inches to a mile, or 1:31,680. These large sheets were prepared for the double purpose of giving information of direct value to the reclamation service and, when photographed down, of being used as part of the complete topographic map. This work was carried on under the immediate direction of Mr. E. C. Barnard, with headquarters at Needles, and of Mr. Robert B. Marshall, with headquarters at Yuma, Ariz. The work was controlled by level lines run down on each side of the river from Needles, and checking across at frequent intervals from side to side.

Through the cooperation arranged with the topographic branch and the work accomplished by the engineers of the reclamation service the triangulation and leveling were extended from the vicinity of Bulls Head, above Needles, Cal., down to the Mexican line below Yuma. The topography along the river was also mapped on a scale of 1:31,680 up to an altitude of 150 feet above the river level for all except about 40 miles of the entire distance. In addition, the general topographic mapping was carried on by the topographic branch, filling out several quadrangles embracing important portions of the stream.

In May the parties along the Colorado were gradually reduced as the hot weather came on, and the labor of the field parties became less effective. The men were distributed to various field parties organized in other States. The extreme heat prevailing along the Colorado, and the high water, rendered systematic investigations expensive and almost impracticable. It was therefore considered desirable during the summer season to work up the results and make plans for vigorously continuing the work during next winter. Mr. E. T. Perkins, in charge of the engineering operations, was transferred to Los Angeles, where he continued the compilation of maps and data leading up to a preliminary report on possibilities of reclamation.

During the spring of 1903 work was begun on the study of the irrigation possibilities along the west side of Sacramento Valley. Mr. H. E. Green, under instructions from Mr. J. B. Lippincott, organized field parties and began a systematic study of reservoir sites along the west side of the valley, of the possibilities of diverting the Sacramento River near the head of the valley, and of utilizing its waters in connection with those of tributary streams from the west.

Mr. S. G. Bennett also continued river measurements, most of these being for general hydrographic information, a few being in direct connection with possible reclamation projects.

Mr. Homer Hamlin continued the investigation of the movement of underground waters and the availability of supplies from this source, as noted on an earlier page. Mr. Hamlin has also brought to completion his studies of the opportunities for reclamation in the Salinas Valley, and prepared for publication a report on the water resources of this area.

Colorado.—The reclamation investigations and hydrographic measurements in this State were carried on by Mr. A. L. Fellows, aided by Mr. M. C. Hinderlider and various assistant engineers and hydrographic aids, some of whom were transferred from work on the Colorado River. The principal operations were those in connection with the Uncompahgre project for diverting water by means of a long tunnel from the Gunnison River to lands in the Uncompahgre Valley near Montrose and Delta. Other projects examined were on the South Platte near Sterling, and on the Grand near Grand Junction, Colo.

The best location, the size, and the grade of the tunnel from the Gunnison were the subject of continued investigation throughout the year. These are governed by topographic considerations, and also by knowledge of the amount of water available, and the extent of the irrigable land. It has been assumed that there is an unlimited supply of water and of land to be irrigated, but careful examinations show that each of these points must be very

carefully considered. The size and grade of the tunnel are not only related to these facts, but are governed by other considerations. By increase of grade the tunnel is lengthened and the speed of the water is increased to the point where it may erode the lining, but the diameter may be reduced. On the other hand, by giving the lightest possible grade to the tunnel the distance may be shortened, but the sectional area must be increased.

The best location for the upper end of the tunnel was also carefully considered, and questions as to whether it is preferable to divert the water on grade at the river by lengthening the tunnel or by constructing a dam in the river. All of these matters involve careful study and the preparation of elaborate estimates of cost.

The mapping of the irrigable land was carried on as rapidly as possible with the somewhat limited force of skilled topographers. Plans were also made for utilizing the power available from the tunnel and employing this in pumping water to land which can not be reached by gravity supplies. The people already owning lands which may be supplied with water from the tunnel have organized under the general form adopted by the water users of the Salt River Valley, Arizona, and every attempt is being made to simplify and facilitate the operations of the engineers.

On the north side of the South Platte River in the northeast corner of Colorado surveys were carried on by Mr. Charles T. Pease, of Denver, Colo., to ascertain the possibility of diverting the flood waters of the South Platte, taking them out by means of a large canal approximately 100 miles long and storing them in a large basin on Pawnee Creek, the outlet of which must be closed by a dam. The waters thus impounded would be used for the irrigation of lands in the vicinity of Sterling, Colo. A withdrawal of lands under survey was made and examinations were carried on during the fall and early winter of 1902. The information obtained was sufficient to show that the project would be extremely

expensive and that the water supply is deficient. The report showing the results of this survey was submitted to a board of consulting engineers consisting of Messrs. George Y. Wisner, Arthur P. Davis, and William H. Sanders. The board recommended that the project be dropped on account of the deficient water supply and of the cost and difficulty of constructing and maintaining a large canal through the region of sand dunes north of the river. The lands which had been temporarily withdrawn pending survey were restored to the public domain.

Surveys in the vicinity of Grand Junction were carried on by Mr. Gerard H. Matthes during 1902, terminating early in the spring of 1903. The canyon of the Grand River was mapped, showing all possible points of diversion for the valley lands above Grand Junction, and the survey was continued around the valley and to what is known as the Excelsior divide, near the State line between Colorado and Utah. It was hoped that it would be practicable to carry water from the Grand River not only to lands near Grand Junction, but also to the desert areas in Utah between the Grand and the Green, the lands here being of excellent quality. It was found impracticable to surmount this divide, and a preliminary survey was made to ascertain whether electric power could be developed economically to lift water to this land. This project, however, was not considered feasible.

The report of Mr. Matthes was submitted to a board of engineers, and the conclusion was reached that a smaller canal than that planned by Mr. Matthes might be constructed to advantage.

The reconnaissance of irrigable lands in the northwestern part of the State was begun by Mr. L. C. Hill and Mr. R. S. Stockton, a number of localities being found where it is probable that detailed surveys should be made in the future.

Idaho.—Mr. D. W. Ross, formerly State engineer, was appointed district engineer in charge of surveys along the Snake River. He was assisted by Messrs. Burke, Hogue, and others. The principal operations were those in con-

nection with the examination of the possibility of reclaiming arid land on both sides of the Snake River in the vicinity of Minidoka. This tract is immediately above an area of land selected by the State of Idaho under the terms of the so-called Carey Act, the reclamation of which is known as the Twin Falls project; the work is being done by private capital, under the auspices of the State.

It was found that at Minidoka a dam can be constructed across the river, and canals taken out on the north and south sides, extending away from the river and covering a large area of fertile land. This is so nearly level that very careful topographic surveys were necessary to ascertain the slope and the best location for the distributing system. As a considerable amount of water must be allowed to pass down the river for the Twin Falls project and other possible irrigation development, it has been considered desirable to plan water-power works, utilizing the fall of this water and furnishing power for lifting other water to lands above the reach of the gravity system.

Examinations were also made as to the possibility of diverting water from the Payette River upon lands west of Boise on the relatively high benches between the Payette and Boise rivers. There are many complications in connection with this project that render it difficult, although from the engineering standpoint alone it is extremely attractive.

Surveys were also begun to ascertain the possibility of diverting waters from the Snake River westward upon arid land in the upper portion of the Snake River Valley, in the vicinity of what is known as Mud Lake. It is probable that a considerable tract can be brought under irrigation at relatively small cost.

Kansas.—An examination of various projects in the western end of this State was made by Mr. W. G. Russell, but none of these appeared to be feasible. The large cost of water storage, when compared with the small and uncertain supply, seems to prohibit elaborate surveys. There are popularly believed to be many possibilities of water storage in western Kansas, but an engineering

study of each of these reveals conditions which render such storage impracticable.

Montana.—In this State Mr. Cyrus C. Babb, with various assistants, carried on extensive surveys and examinations looking to the utilization of the Milk River and the reenforcement of its flow by waters stored in St. Mary Lake. There are many difficulties to be encountered, both from an engineering standpoint and as a result of the attempt made by various individuals to secure certain advantages for themselves or force the payment of large amounts of money for claims or rights. The mapping of irrigable lands was taken up in cooperation with the topographic section, under Mr. E. M. Douglas, and work showing the altitude and slope of these areas was systematically carried on. Canal surveys were also made from the Milk River showing the location and the cost, and land titles were looked into and arrangements made, wherever necessary and practicable, to secure right of way for use of lands which may be needed in the future. In addition a reconnaissance of various other opportunities of reclamation was made, particularly in the areas south of the Missouri River and on the headwaters of the Musselshell.

Nebraska.—The principal irrigable area lies along the North Platte in the western end of this State. The development of this land rests largely upon the storage and best use of the waters of the North Platte in the State of Wyoming. Investigations therefore were directed toward a survey of the reservoir sites in Wyoming and the possibility of diverting water in that State by means of large canals which will continue into western Nebraska. This work is of great magnitude and involves a thorough knowledge of portions of the river which as yet have hardly been explored. These operations are described on a later page under "Wyoming."

Nevada.—The operations in Nevada were under the charge of Mr. L. H. Taylor. He gave most attention to the Truckee River, making surveys and examination of the possibility of storage of water in Lake Tahoe and

other natural basins near the head. The possibility of diverting this river by means of a high-line canal extending northerly into Spanish Springs Valley was studied, and the expense found to be so large as to be almost prohibitory. Farther down the stream, however, in the vicinity of Wadsworth, it was found practicable to divert the flood and surplus waters by means of a canal on the south side of the river that will carry the water over what is known as Ragtown Pass into the lower Carson reservoir site. It is proposed to construct on the lower Carson a reservoir which will impound not only floods of the Carson but excess water from the Truckee River, and to utilize this supply upon the lands around Carson Lake. The diversion canal from the Truckee will also be used to irrigate lands between Wadsworth and Ragtown or Leetville. Plans and specifications for this canal have been made by Mr. J. H. Quinton, and bids for construction have been advertised for.

In addition to this work lands were temporarily withdrawn pending survey of reservoir sites on the Humboldt River. The best use of the waters of this stream is joined with the problem of the utilization of the excess waters of the Carson and the Truckee. If the waters of the Humboldt can be utilized on lands along the upper and middle portions of its course, greater economy will result and the irrigable area can be extended.

New Mexico.—In this Territory surveys were made along the Rio Grande by Mr. James A. French, these being intended to ascertain the best reservoir sites above the Mesilla Valley in the vicinity of Elephant Butte and northward. Detailed maps were made showing the topography of the river bottom and of the slopes up to about 150 feet above the river, exhibiting all of the opportunities for water storage.

On the Pecos River and its tributaries surveys were made by Mr. W. M. Reed, of Roswell, N. Mex., the principal localities being on the Hondo River and north of Roswell, in the vicinity of what is known as Urton Lake. A reconnaissance was also made of the possibility of

water storage near Las Vegas and of diversion of tributaries of the San Juan River in the northwest corner of the Territory.

There is in New Mexico a Territorial commission on irrigation, which has given advice and assistance in connection with the various projects for reclamation that have been called to the attention of the engineers of the reclamation service.

North Dakota.—In this State examinations were made by Mr. F. E. Weymouth. There is a vast extent of arid land in the western part of the State, and a large amount of water flowing in the Missouri River. This water is, however, far below the level of the vacant land, and it is practically impossible to utilize it, except occasionally by pumping. The fall of the Missouri and its principal tributaries is very slight, so that water power can not be economically had. On the other hand, however, there are in this region vast beds of low-grade coal or lignite. An examination of some of these has been made by Prof. Frank A. Wilder, State geologist, and facts bearing on the possibility of utilizing the lignite in the production of power for pumping have been obtained.

Mr. Weymouth extended his search for reclamation projects to various tributaries of the Missouri River, and up the Yellowstone into Montana, in order to exhaust all of the suggestions, both practicable and impracticable, which have been seriously made, and to discover, if possible, any way of irrigating the arid lands lying within the borders of the State.

Oklahoma.—Mr. Gerard H. Matthes, assisted by Mr. Ferdinand Bonstedt, began a systematic study of the opportunities of reclamation in Oklahoma. This Territory is for the most part within the subhumid or semiarid region, and only the long, narrow prolongation, known as Beaver County, has a truly arid climate. The western part of Oklahoma is dry, but the average farmer when asked about irrigation frankly states that none is practiced and that, in his opinion, it is not necessary. When, however, he learns that the National Government has funds

available for irrigation his attitude quickly changes and he dilates upon the benefits which might be derived from the expenditure of this money. As a matter of fact, irrigation would be highly beneficial in the western part of the Territory if the people residing there would be content to cultivate carefully small areas and to apply the water as needed. As a rule, however, the ambition of the farmer in this part of the country is to possess a broad extent of acreage and to till this by machinery with the minimum of hand labor. The idea of concentrating his efforts upon a 40-acre tract and doing practically all of the labor by hand is, in his opinion, a decided step backward.

The slight fall of the streams, their erratic flow, and the gently undulating character of the country render the introduction of irrigating systems extremely difficult and expensive. A number of reservoir sites have been examined and canal lines run out, but in comparison with the opportunities for reclamation offered in the arid region the conditions in Oklahoma appear to be of small moment.

In addition to the reclamation work in Oklahoma, Mr. Matthes has been instructed to supervise the construction of waterworks, buildings, and other public improvements at the towns of Hobart, Anadarko, and Lawton, and of bridges in the counties of which these are the county seats. This work is to be paid for from the town-lot fund established by act of Congress, resulting from the auction sale of lots in the towns named.

Oregon.—Work in this State was under the charge of Mr. John T. Whistler, who was transferred from charge of operations at Bulls Head, on the Colorado River. A preliminary reconnaissance was made by Mr. James G. Camp to ascertain whether water from the Snake could be diverted by a long canal and carried out on the south side of the stream to arid bench lands in southern Washington and northern Oregon. This was found to be impracticable, but other projects more promising were found in the vicinity of Pendleton. In particular a survey was made of the region west of lower Umatilla River, where it is

apparent that storm waters can be stored and utilized upon the arid land. This project is being carefully surveyed to ascertain its cost and feasibility. Other surveys were begun in the vicinity of Burns, in the central part of the State, and along the Malheur River in the eastern end of the State. These surveys involve the construction of storage reservoirs, as the rivers have a low summer flow.

South Dakota.—The principal irrigation possibilities in this State are those around or near the Black Hills, from which issue a considerable number of small, torrential streams. These streams have cut through the bounding ridges of the Black Hills, and there are apparently a considerable number of reservoir sites. Nearly all of these, however, are of small capacity and require dams which will be very expensive to construct. Preliminary examinations were made by Mr. Raymond F. Walter, and parties outfitted for systematic survey, the work being under the general charge of Mr. Charles H. Fitch.

Utah.—Prof. George L. Swendsen continued the survey of the vicinity of Bear Lake, examining the opportunities for storing water in this lake for use on the irrigable lands along the Bear River in Idaho and Utah. Work was also begun on the examination of Utah Lake as a storage reservoir, and a reconnaissance was made of the opportunities for water storage in what is known as Joes Valley, in the central part of the State.

The last legislature of Utah created a commission that is charged with the duty of cooperating or assisting in carrying out the reclamation law. The chairman is the State engineer, Mr. A. F. Doremus. As its representative, or attorney, the commission has employed Mr. F. S. Richards, of Salt Lake City, and a resolution has been passed asking the Secretary of the Interior to take up first the study of Utah Lake. This, as above stated, has been begun. The first question to be definitely settled is whether there is a surplus of water which can be stored in Utah Lake. For some time there has been no natural flow from this lake. Water has been forced out through

the Jordan River by means of pumps. It is probably not practicable, owing to the excessive evaporation, to store water in this lake for more than one season at a time; and one of the important questions to be answered is whether the area of the lake can be reduced, decreasing the evaporation losses, or whether the floods now disappearing in the lake can be kept back or utilized directly for irrigation.

Washington.—The project first presented in this State is that connected with the utilization of the waters of the Yakima River. A reconnaissance was made by Mr. T. A. Noble, in charge of work in this State, and the conclusion was reached that the conditions are so involved that at the present time it is not feasible to take up surveys along this stream. An examination of the Okanogan River showed that arid lands might be reclaimed here without excessive difficulties, and detailed surveys were therefore begun to develop the important facts.

The largest opportunity for reclamation in the State of Washington, and possibly in the arid West, is that connected with the irrigation of lands in what is known as the Big Bend of the Columbia River. To bring water to these areas will involve the construction of a complicated and expensive irrigation system. The magnitude of the undertaking is so great that careful surveys must be conducted through several seasons to render a wise conclusion possible. Work has been begun to ascertain whether, in a general way, the project is feasible.

Wyoming.—In the northern part of this State work was first begun under Mr. Jeremiah Ahern, to determine the practicablility of utilizing Lake De Smet as a storage reservoir, taking the waters of Piney Creek into this reservoir and diverting them again upon lands near Sheridan. There are on the head of Piney Creek three small reservoir sites, one of which has been utilized by private effort. Complete data concerning water supply is lacking, and after careful examination the conclusion was reached that further work will not be justified until more accurate knowledge concerning this supply has been obtained.

The whole project is on the border line of practicability, but without a better knowledge of the amount of water available a favorable conclusion can not be reached. Stream gagings made during the closing days of the year indicate that the Lake De Smet project is feasible.

One of the largest bodies of irrigable land in Wyoming is in the vicinity of Cody, on the north side of the Shoshone River. This has been segregated under the terms of the Carey Act and held for development, surveys having been made by Cody and Salisbury, and estimates of construction prepared. Private capital being unobtainable, negotiations have been begun looking to the irrigation of this land under the terms of the reclamation law. Mr. Jeremiah Ahern began in the spring of 1903 a careful survey of the canyon of the Shoshone River above Cody, and the preparation of estimates of the cost of taking out a canal to irrigate the largest possible area of good land.

The principal river of the southern part of Wyoming is the North Platte. Irrigation has been developed along this stream in Wyoming and western Nebraska, and a large number of projects have been examined by private capital. The present water supply is ample for all purposes and for development in the near future, but if large canals are to be built, extending into western Nebraska, the supply must be reenforced. An examination of the irrigable lands and reservoir sites along this stream was begun by Mr. John E. Field, formerly State engineer of Colorado. In particular, attention was given to the reservoir site on the Sweetwater River a short distance above its junction with the North Platte, at what is known as Devils Gap. Here a large reservoir could be constructed at small cost, the gap being a narrow, nearly vertical cut in a low granite hill. The water held by a dam at this point would flood a broad valley now occupied by the Tom Sun ranch. The principal questions here have been, first, the quantity of supply, the Sweetwater being a relatively small stream; and next, whether the water, if held, could be utilized. The vacant lands immediately below this reservoir site are largely

alkaline in character, containing many small alkali lakes which have been taken up under the mineral laws. Other lands are hummocky, and the total extent of good irrigable area is relatively so small that it is questionable whether the construction of the dam at this point could be justified.

Below the mouth of the Sweetwater are various other reservoir sites which, although involving a more extensive dam, have a larger water supply, this being the combined flow of the North Platte and Sweetwater rivers. Examinations of these reservoir sites were begun in order to determine the relative merits of the various localities.

Along the North Platte River, below the reservoir sites above noted, are many bodies of good land. Some of these apparently can be irrigated by ordinary canals from the river; others lie at such an altitude that exceedingly long and expensive diversion lines will be needed to reach them. From casual inspection it appears as though, as popularly stated, there is an unlimited supply of water and of land. A careful measurement of the waters and precise level lines run show that the opportunities for reclamation, while in one sense good, are not so simple as generally supposed, and that the most careful engineering work will be necessary, and many alternatives must be studied, before the best plan can be selected.

If it were merely a question of building a reservoir and holding water it would be practicable to construct at once the dam on the Sweetwater, but when built the questions would arise, Where can this water be used and what land will it reclaim? and Could not these results have been obtained in a better way? Answers to these questions require long and patient investigation by skilled men. Satisfactory results can not be obtained by hasty assumptions.

PUBLICATION BRANCH.

Editorial Division.

TEXTS.

Mr. Philip C. Warman remained in charge of this section. He was assisted by Messrs. George M. Wood and

L. F. Schmeckebier throughout the year; Mr. Charles E. Edgerton from April 1 to May 31, when he resigned; Mr. Charles A. Mansuy until June 1, when he was transferred to the hydrographic branch; and Mr. Alfred C. Cosdon after June 1. The following tables exhibit the character and amount of the work performed:

Manuscripts edited during the year 1902–3.

Publication.	Pages (usually typewritten).
Twenty-third Annual Report	353
Monograph XLIII	515
Monograph XLIV	487
Monograph XLV	693
Monograph XLVI	1,000
Professional Paper No. 10	114
Professional Paper No. 11	510
Professional Paper No. 12	387
Professional Paper No. 13	174
Professional Paper No. 14	428
Professional Paper No. 15	106
Professional Paper No. 16	1,095
Professional Paper No. 17	65
Professional Paper No. 18	128
Professional Paper No. 19	229
Bulletin No. 201	371
Bulletin No. 202	43
Bulletin No. 203	364
Bulletin No. 206	197
Bulletin No. 207	88
Bulletin No. 208	393
Bulletin No. 209	153
Bulletin No. 210	315
Bulletin No. 211	293
Bulletin No. 212	292
Bulletin No. 213	827
Bulletin No. 214	272
Bulletin No. 215	1,207
Bulletin No. 216	446
Bulletin No. 217	127
Bulletin No. 218	135
Bulletin No. —— (Cragin and Stanton)	130

Manuscripts edited during the year 1902–3—Continued.

Publication.	Pages (usually typewritten).
Water-Supply Paper No. 72	125
Water-Supply Paper No. 74	220
Water-Supply Paper No. 75	481
Water-Supply Paper No. 76	156
Water-Supply Paper No. 77	155
Water-Supply Paper No. 78	77
Water-Supply Paper No. 79	288
Water-Supply Paper No. 80	154
Water-Supply Paper No. 81	781
Water-Supply Paper No. 82	319
Water-Supply Paper No. 83	513
Water-Supply Paper No. 84	302
Water-Supply Paper No. 85	348
Water-Supply Paper No. 86	79
Water-Supply Paper No. 87	230
Water-Supply Paper No. 88	90
Geologic Folio No. 83	234
Geologic Folio No. 84	95
Geologic Folio No. 85	83
Geologic Folio No. 86	93
Geologic Folio No. 87	20
Geologic Folio No. 88	32
Geologic Folio No. 89	87
Geologic Folio No. 90	67
Geologic Folio No. 91	54
Geologic Folio No. 92	125
Geologic Folio No. 93	124
Geologic Folio No. 94	308
Geologic Folio No. 95	76
Geologic Folio No. 96	87
Geologic Folio (Indiana, Pa.)	100
Mineral Resources for 1901 (in part)	930
Mineral Resources for 1902 (in part)	523
First Annual Report of the Reclamation Service	566
Regulations of the Survey	60
Instructions relating to work of the Survey	153
List of Publications of the U. S. Geological Survey	45
Press bulletins	639
Total number of manuscript pages edited	20,756

Proof sheets read and corrected during the year 1902–3.

Publication.	Final printed pages.
Twenty-third Annual Report	246
Monograph XLII	244
Monograph XLIII	354
Monograph XLIV	403
Monograph XLV	482
Professional Paper No. 1	126
Professional Paper No. 2	86
Professional Paper No. 3	182
Professional Paper No. 4	47
Professional Paper No. 5	43
Professional Paper No. 6	57
Professional Paper No. 7	134
Professional Paper No. 8	210
Professional Paper No. 9	343
Professional Paper No. 10	81
Professional Paper No. 11	311
Professional Paper No. 12	201
Professional Paper No. 13	134
Professional Paper No. 14	501
Professional Paper No. 16	541
Bulletin No. 195	30
Bulletin No. 196	87
Bulletin No. 197	284
Bulletin No. 198	49
Bulletin No. 199	319
Bulletin No. 200	29
Bulletin No. 201	167
Bulletin No. 202	26
Bulletin No. 203	148
Bulletin No. 204	175
Bulletin No. 205	125
Bulletin No. 206	119
Bulletin No. 207	57
Bulletin No. 208	243
Bulletin No. 209	133
Bulletin No. 210	153
Bulletin No. 211	133
Bulletin No. 212	189
Bulletin No. 213	454
Bulletin No. 214	290

Proof sheets read and corrected during the year 1902-3—Continued.

Publication.	Final printed pages.
Bulletin No. 215	238
Water-Supply Paper No. 66	192
Water-Supply Paper No. 67	118
Water-Supply Paper No. 68	102
Water-Supply Paper No. 69	142
Water-Supply Paper No. 70	65
Water-Supply Paper No. 71	153
Water-Supply Paper No. 72	90
Water-Supply Paper No. 73	85
Water-Supply Paper No. 74	166
Water-Supply Paper No. 75	265
Water-Supply Paper No. 76	127
Water-Supply Paper No. 77	72
Water-Supply Paper No. 78	62
Water-Supply Paper No. 79	198
Water-Supply Paper No. 80	110
Water-Supply Paper No. 81	485
Water-Supply Paper No. 82	204
Water-Supply Paper No. 83	310
Geologic Folio No. 81	14
Geologic Folio No. 82	21
Geologic Folio No. 83	19
Geologic Folio No. 84	8
Geologic Folio No. 85	6
Geologic Folio No. 86	7
Geologic Folio No. 87	4
Geologic Folio No. 88	5
Geologic Folio No. 89	6
Geologic Folio No. 90	9
Geologic Folio No. 91	6
Geologic Folio No. 92	9
Mineral Resources for 1901 (in part; some chapters abridged in making up volume)	1,121
Mineral Resources for 1902 (in part)	216
Regulations of U. S. Geological Survey	52
Instructions relating to work of U. S. Geological Survey	131
List of Publications of U. S. Geological Survey	47
Press bulletins	132
Total number of pages of proof (including plates) read and corrected	12,933

The reading of the proof sheets of the publications tabulated above required the handling of 5,522 galleys and 23,631 page proofs.

Indexes prepared during the year 1902-3.

Publication.	Pages indexed.
Twenty-third Annual Report	217
Monograph XLII	211
Monograph XLIII	316
Monograph XLIV	351
Monograph XLV	463
Professional Paper No. 1	120
Professional Paper No. 2	70
Professional Paper No. 3	167
Professional Paper No. 4	36
Professional Paper No. 5	38
Professional Paper No. 6	42
Professional Paper No. 7	110
Professional Paper No. 8	194
Professional Paper No. 9	298
Professional Paper No. 10	68
Professional Paper No. 11	298
Professional Paper No. 12	168
Professional Paper No. 13	111
Professional Paper No. 14	495
Bulletin No. 195	24
Bulletin No. 196	29
Bulletin No. 198	43
Bulletin No. 199	192
Bulletin No. 200	23
Bulletin No 201	164
Bulletin No. 202	21
Bulletin No. 204	153
Bulletin No. 205	94
Bulletin No. 206	112
Bulletin No. 208	229
Bulletin No. 209	122
Bulletin No. 210	147
Bulletin No. 211	123
Bulletin No. 212	174
Bulletin No. 213	449
Water-Supply Paper No. 65	334
Water-Supply Paper No. 66	188

Indexes prepared during the year 1902-3—Continued.

Publication.	Pages indexed.
Water-Supply Paper No. 67	106
Water-Supply Paper No. 68	90
Water-Supply Paper No. 69	124
Water-Supply Paper No. 70	50
Water-Supply Paper No. 71	137
Water-Supply Paper No. 72	75
Water-Supply Paper No. 73	54
Water-Supply Paper No. 74	151
Water-Supply Paper No. 75	246
Water-Supply Paper No. 76	108
Water-Supply Paper No. 77	62
Water-Supply Paper No. 78	53
Water-Supply Paper No. 79	192
Water-Supply Paper No. 80	104
Water-Supply Paper No. 82	199
Water-Supply Paper No. 83	304
Mineral Resources for 1901	996
Total number of pages indexed	9,445

The best indications of the amount of work done in this section are the number of final pages approved for printing and the number of such pages indexed. These show a decided increase over last year.

The copy and proofs of all account and record books and blanks, circulars, office cards, etc., are examined and approved in this section. This work consumes a large part of the time of one person, but it is not practicable to report the amount statistically.

In addition to the regular work, a great deal of time was devoted to completing the preparation and reading the proofs of Bulletin No. 215, a "Catalogue and Index of the Publications of the United States Geological Survey, 1901 to 1903." This is supplementary to Bulletin No. 177, the two constituting a general index of the publications of the Survey from the time of its establishment, in 1879, to the present.

The division of mining and mineral resources continued to render special assistance in copy preparing and proof reading for the volume on mineral resources.

GEOLOGIC MAPS.

This section remained in charge of Mr. George W. Stose, who was assisted throughout the year by Messrs. O. A. Ljungstedt and H. S. Selden, from July 1 to October 15 by Mr. H. V. Leménager, and from October 15 to July 1, 1903, by Miss Ida C. Rogers, Mr. Leménager being transferred to the division of hydrography and Miss Rogers being appointed to fill the vacancy thus created.

Mr. Stose devoted his time chiefly to editing folio manuscripts, preparing maps for engraving, planning color schemes for folios, and supervising in general the work of the section. The descriptive texts were also read by Mr. Willis, geologist in charge of the section of areal geology, and by some one in the textual section of the editorial division, where the proofs of the texts were also read and corrected. Mr. Stose also arranged a provisional color scheme and modified the general plan of folio publication so as to make it conform to the revised rules of nomenclature.

Mr. Ljungstedt continued to look after the details of drafting and proof reading, and acted as editor during Mr. Stose's absence from the office. Mr. Selden, Mr. Leménager, and Miss Rogers read the proofs, prepared copy for engraving and color work, and drew sections and illustrations for the folios.

At the beginning of the fiscal year 15 folios were in process of engraving, and 6 were on file ready for engraving. Within the year 11 additional folios were transmitted to the division, and 13 (Nos. 80–92, inclusive) were completed and delivered. At the close of the year, 16 folios were in process of engraving, and 3 were in the files of the section.

The New York, Chicago, Masontown-Uniontown, and Norfolk folios were nearly completed during the previous

fiscal year, but were actually issued last year, and are therefore included in this report.

The complete list of folios published to June 30, 1903, is as follows:

Geologic folios published to June 30, 1903.

No.	Name of folio.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cent.
1	Livingston	Montana	110°–111°	45°–46°	3,354	25
2	Ringgold	Georgia; Tennessee	85°–85° 30′	34° 30′–35°	980	25
3	Placerville	California	120° 30′–121°	38° 30′–39°	932	25
4	Kingston[a]	Tennessee	84° 30′–85°	35° 30′–36°	969	25
5	Sacramento	California	121°–121° 30′	38° 30′–39°	932	25
6	Chattanooga[a]	Tennessee	85°–85° 30′	35°–35° 30′	975	25
7	Pikes Peak (including Cripple Creek map).[a]	Colorado	105°–105° 30′	38° 30′–39°	932	25
8	Sewanee	Tennessee	85° 30′–86°	35°–35° 30′	975	25
9	Anthracite-Crested Butte.[a]	Colorado	106° 45′–107° 15′	38° 45′–39°	465	50
10	Harpers Ferry[a]	Virginia; West Va; Maryland	77° 30′–78°	39°–39° 30′	925	25
11	Jackson	California	120° 30′–121°	38°–38° 30′	938	25
12	Estillville	Virginia; Kentucky; Tennessee	82° 30′–83°	36° 30′–37°	957	25
13	Fredericksburg	Maryland; Virginia	77°–77° 30′	38°–38° 30′	938	25
14	Staunton	Virginia; West Va	79°–79° 30′	38°–33° 30′	938	25
15	Lassen Peak	California	121°–122°	40°–41°	3,634	25
16	Knoxville	Tennessee; N. Carolina	83° 30′–84°	35° 30′–36°	969	25
17	Marysville	California	121° 30′–122°	39°–39° 30′	925	25
18	Smartsville	do	121°–121° 30′	39°–39° 30′	925	25
19	Stevenson	Alabama; Georgia; Tennessee	85° 30′–86°	34° 30′–35°	980	25
20	Cleveland	Tennessee	84° 30′–85°	35°–35° 30′	975	25
21	Pikeville	do	85°–85° 30′	35° 30′–36°	969	25
22	McMinnville	do	85° 30′–86°	35° 30′–36°	969	25
23	Nomini	Maryland; Virginia	76° 30′–77°	38°–38° 30′	938	25
24	Three Forks	Montana	111°–112°	45°–46°	3,354	50
25	Loudon	Tennessee	84°–84° 30′	35° 30′–36°	969	25
26	Pocahontas	Virginia; West Va	81°–81° 30′	37°–37° 30′	950	25
27	Morristown	Tennessee	83°–83° 30′	36°–36° 30′	963	25
28	Piedmont	Maryland; West Va	79°–79° 30′	39°–39° 30′	925	25
29	Nevada City Special:					
	Nevada City	California	120° 00′ 25″–121° 03′ 45″	39° 13′ 50″–39° 17′ 16″	11.65	50
	Grass Valley	California	121° 01′ 35″–121° 05′ 04″	39° 10′ 22″–39° 13′ 50″	12.09	50
	Banner Hill	California	120° 57′ 05″–121° 00′ 25″	39° 13′ 50″–39° 17′ 16″	11.65	50

[a] Out of stock.

Geologic folios published to June 30, 1903—Continued.

No.	Name of folio.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
30	Yellowstone National Park: Gallatin, Canyon, Shoshone, Lake	Wyoming	110°–111°	44°–45°	3,412	75
31	Pyramid Peak	California	120°–120° 30′	38° 30′–39°	932	25
32	Franklin	Virginia, West Va.	79°–79° 30′	38° 30′–39°	932	25
33	Briceville	Tennessee	84°–84° 30′	36°–36° 30′	963	25
34	Buckhannon	West Va.	80°–80° 30′	38° 30′–39°	932	25
35	Gadsden	Alabama	86°–86° 30′	34°–34° 30′	986	25
36	Pueblo	Colorado	104° 30′–105°	38°–38° 30′	938	50
37	Downieville	California	120° 30′–121°	39° 30′–40°	919	25
38	Butte Special	Montana	112° 29′ 30″–112° 36′ 42″	45° 59′ 28″–46° 02′ 54″	22.8	50
39	Truckee	California	120°–120° 30′	39°–39° 30′	925	25
40	Wartburg	Tennessee	84° 30′–85°	36°–36° 30′	963	25
41	Sonora	California	120°–120° 30′	37° 30′–38°	944	25
42	Nueces	Texas	100°–100° 30′	29° 30′–30°	1,035	25
43	Bidwell Bar	California	121°–121° 30′	39° 30′–40°	919	25
44	Tazewell	Virginia, West Va.	81° 30′–82°	37°–37° 30′	950	25
45	Boise	Idaho	116°–116° 30′	43° 30′–44°	864	25
46	Richmond	Kentucky	84°–84° 30′	37° 30′–38°	944	25
47	London	do	84°–84° 30′	37°–37° 30′	950	25
48	Tenmile District Special.	Colorado	106° 08′–106° 16′ 08″	39° 22′ 57″–39° 30′ 25″	62.2	25
49	Roseburg	Oregon	123°–123° 30′	43°–43° 30′	871	25
50	Holyoke	Mass., Conn	72° 30′–73°	42°–42° 30′	885	50
51	Big Trees	California	120°–120° 30′	38°–38° 30′	938	25
52	Absaroka: Crandall, Ishawooa	Wyoming	109° 30′–110°	44°–45°	1,706	25
53	Standingstone	Tennessee	85°–85° 30′	36°–36° 30′	963	25
54	Tacoma	Wash	122°–122° 30′	47°–47° 30′	812	25
55	Fort Benton	Montana	110°–111°	47°–48°	3,234	25
56	Little Belt Mountains.	do	110°–111°	46°–47°	3,295	25
57	Telluride	Colorado	107° 45′–108°	37° 45′–38°	236	25
58	Elmoro	do	104°–104° 30′	37°–37° 30′	950	25
59	Bristol	Virginia, Tennessee	82°–82° 30′	36° 30′–37°	957	25
60	La Plata	Colorado	108°–108° 15′	37° 15′–37° 30′	237	25
61	Monterey	Virginia, West Va.	79° 30′–80°	38°–38° 30′	938	25
62	Menominee Special	Michigan	An irregular area	About 20 m. long	125	25
63	Mother Lode District (the Gold Belt).	California	NW.-SE. rectangle	About 70 m. long, 6 m. wide.	428	50
64	Uvalde	Texas	99° 30′–100°	29°–29° 30′	1,040	25
65	Tintic Special	Utah	111° 55′–112° 10′	39° 45′–40°	229	25
66	Colfax	California	120° 30′–121°	39°–39° 30′	925	25
67	Danville	Illinois, Indiana	87° 30′–87° 45′	40°–40° 15′	228	25

Geologic folios published to June 30, 1903—Continued.

No.	Name of folio.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
68	Walsenburg	Colorado	104° 30′–105°	37° 30′–38°	944	25
69	Huntington	West Va.; Ohio	82°–82° 30′	38°–38° 30′	938	25
70	Washington	D. C; Virginia; Maryland	76° 45′–77° 15′	38° 45′–39°	465	50
71	Spanish Peaks	Colorado	104° 30′–105°	37°–37° 30′	950	25
72	Charleston	West Va.	81° 30′–82°	38°–38° 30′	938	25
73	Coos Bay	Oregon	124°–124° 30′	43°–43° 30′	871	25
74	Coalgate	Ind. T	96°–96° 30′	34° 30′–35°	980	25
75	Maynardville	Tennessee	83° 30′–84°	36°–36° 30′	963	25
76	Austin	Texas	97° 30′–98°	30°–30° 30′	1,030	25
77	Raleigh	West Va.	81°–81° 30′	37° 30′–38°	944	25
78	Rome	Georgia; Alabama	85°–85° 30′	34°–34° 30′	986	25
79	Atoka	Ind. T	96°–96° 30′	34°–34° 30′	986	25
80	Norfolk	Virginia; N. Carolina	75° 30′–76° 30′	36° 30′–37°	1,913	25
81	Chicago: Riverside, Chicago, Desplaines, Calumet	Illinois; Indiana	87° 30′–88°	41° 30′–42°	892	50
82	Masontown-Uniontown.	Pa.	79° 30′–80°	39° 45′–40°	458	25
83	New York City: Paterson, Harlem, Staten Island, Brooklyn	New York; New Jersey	73° 45′–74° 15′	40° 30′–41°	906	50
84	Ditney	Indiana	87°–87° 30′	38°–38° 30′	938	25
85	Oelrichs	S. Dak; Nebraska	103°–103° 30′	43°–43° 30′	871	25
86	Ellensburg	Wash	120° 30′–121°	46° 30′–47°	820	25
87	Camp Clarke	Nebraska	103°–103° 30′	41° 30′–42°	892	25
88	Scotts Bluff	do	103° 30′–104°	41° 30′–42°	892	25
89	Port Orford	Oregon	124°–124° 30′	42° 30′–43°	878	25
90	Cranberry	Tennessee	81° 30′–82°	36°–36° 30′	963	25
91	Hartville	Wyoming	104° 30′–105°	42°–42° 30′	885	25
92	Gaines	Pa; New York	77° 30′–77° 45′	41° 45′–42°	223	25

The following folios were in process of engraving at the close of the fiscal year, the second column giving the stage of the work on each:

Geologic folios in process of engraving June 30, 1903.

Name.	Stage.
Alexandria, S. Dak	Maps printed.
Brownsville-Connellsville, Pa	Do.
Columbia, Tenn	Do.
Edgemont, S. Dak.-Nebr	Engraving begun.
Elkland-Tioga, N. Y	Maps printed.
Globe, Ariz	Engraving begun.
Indiana, Pa	Maps transferred to stone.
Mitchell, S. Dak	Maps printed.
Mount Stuart, Wash	Engraving begun.
Nampa, Idaho	Maps transferred to stone.
Newcastle, Wyo.-S. Dak	Maps engraved.
Olivet, S. Dak	Maps printed.
Parker, S. Dak	Do.
San Luis, Cal	Color stones in preparation.
Silver City, Idaho	Maps engraved.
Tishomingo, Ind. T	Color stones in preparation.

At the close of the year the Brownsville-Connellsville, Olivet, and Parker folios were nearly finished. The New York, Chicago, Masontown-Uniontown, Brownsville-Connellsville, and Elkland-Tioga are double folios, each containing maps representing two or four adjoining quadrangles, and therefore being equivalent to two or four ordinary folios.

TOPOGRAPHIC MAPS.

This section continued in charge of Mr. S. J. Kübel, Mr. James McCormick having direct supervision of the work, assisted by Messrs. H. W. Elmore, J. W. Brashears, H. S. Lewis, and A. N. Gardner.

The work of this section consists chiefly of editing or preparation of manuscripts and proof reading. The manuscripts of all maps submitted for publication—atlas sheets, special maps, general maps, and maps for text illustration—are examined in this section, corrected if

correction is necessary, and approved for engraving, as are also all proposed corrections of published maps. The proof reading consists in a detailed comparison of prints from the engraved plates with the manuscript and the marking of the errors for correction.

In Group I, on pages 252 to 254, are enumerated the new topographic atlas sheets which were edited and proof read during the year, while the two lists "new editions" (p. 257) and "sheets corrected" (p. 258) enumerate the atlas sheets, corrections to which were edited and proof read.

Following is a list of maps intended for text illustration which were edited during the year. The proof reading of these is done in the section of illustrations.

Twenty-third Annual Report	24
Twenty-fourth Annual Report	24
Bulletins Nos. 200, 201, 205, 206, 208, 209, 211, 212	45
Monographs XLIII and XLV	56
Water-Supply and Irrigation Papers Nos. 73, 75, 77, 78, 79, 80, 81, 86, 87	121
Professional Papers Nos. 2, 3, 5, 9, 10, 11, 12, 13, 15	42
Total	312

The circulars and index maps showing progress of surveys and publication of maps are revised from time to time in this section and prepared for reissue.

ILLUSTRATIONS.

The section of illustrations remained in charge of Mr. John L. Ridgway. On November 8 Mr. D. W. Cronin's resignation was accepted, and on March 24 Mr. Martin Solem was appointed in his place. The draftsmen assigned to this section are: Messrs. H. Chadwick Hunter, H. Hobart Nichols, F. W. von Dachenhausen, Martin Solem, J. H. Pellen, and Misses Frances Wieser and Mary M. Mitchell. Mr. L. B. Jay is general assistant.

The principal work consists of: First, the preparation of new drawings from crude originals, and the shaping and completing of drawings and other copies transmitted to accompany manuscripts; second, the drawing of specimens; third, the retouching of photographs for purposes

of reproduction; fourth, the selection of suitable processes and the writing of specifications; fifth, the examination and correction of proofs.

During the year 3,646 drawings were prepared, an increase over the previous year of about 25 per cent. They classify as follows:

Geologic and topographic maps	283
Paleontologic drawings	1,502
Photographs prepared for reproduction	463
Diagrams and sections	462
Landscapes	1
Lithologic drawings	18
Miscellaneous	917
	3,646

The processes adopted for the reproduction of drawings transmitted during the year, with the number of subjects reproduced by each, are shown in the following list:

Chromolithography	132
Photolithography	1
Photogelatin	24
Wax engraving	230
Half-tone engraving	556
Zinc etching	249
Three-color process	7
From previously engraved plates	113

Illustrations were transmitted to accompany the following manuscripts:

Twenty-third and Twenty-fourth Annual Reports.

Monographs XLII, XLIII, XLIV, XLV, XLVI.

Professional Papers Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19.

Bulletins Nos. 196, 198, 199, 200, 201, 204, 205, 206, 208, 209, 210, 211, 212, 213, 214, 216, 217.

Water-Supply and Irrigation Papers Nos. 73, 74, 75, 76, 77, 78, 79, 80, 81, 86, 87, 88.

Mineral Resources for 1902.

First Annual Report of Reclamation Service (H. Doc. No. 79, 57th Cong., 2d sess).

Engraved proofs of illustrations to the number of 1,568 were received and examined critically. An examination was also made of all illustrations received at the Government Printing Office for insertion in Survey publications. This examination resulted in the rejection of 10,156 copies.

During the year 53 requests for electrotypes were received and filled. The number of cuts represented in these orders was 358.

PHOTOGRAPHY.

The photographic laboratory was continued under the direction of Mr. Norman W. Carkhuff, who was assisted by Messrs. John Erbach, Charles A. Ross, Nelson H. Kent, E. A. Shuster, jr., Edward M. Bane, and Edward F. Wahl. In January Mr. Kent was transferred to the biological laboratory of the Agricultural Department.

The amount of work performed in this section, while showing a decrease in the total number of negatives and prints made, was as great as that done the previous year, owing to the large sizes of the negatives and prints. The work for the last six months of the year was unusually heavy on account of the demands of the reclamation service.

About 1,000 fossils and other photographic specimens were photographed.

The work of cataloguing the slide collection was continued. As in previous years, several schools made use of this collection for educational purposes.

Following is a tabulated statement of the work of the laboratory for the year:

Sizes of negatives and prints made in 1902-3.

Size.	Negatives.	Prints.
28 by 34	366	1,594
22 by 28	119	764
20 by 24	494	2,351
14 by 17	99	349
11 by 14	108	492
8 by 10	159	596
6½ by 8½	209	900
5 by 7	1,103	5,256
4 by 5	2,205	4,629
3¼ by 4¼	687	1,581
Lantern slides	219	....
Total	5,768	18,512

GROUP I.—*Topographic atlas sheets and other maps engraved and published or in press during the fiscal year 1902–3.*

Quadrangle and State.	Position of SE. corner. Latitude.		Longitude.		Contour interval.	Scale.
	°	′	°	′	Feet.	
Aladdin, Wyo.-S. Dak.-Mont	44	30	104	00	50	1:125,000
Alexandria Bay, N. Y	44	15	75	45	20	1:62,500
Babylon, N. Y	40	30	73	15	20	1:62,500
Bangor, Me	44	45	68	45	20	1:62,500
Big Moose, N. Y	43	45	74	45	20	1:62,500
Bisbee, Ariz	31	15	109	45	50	1:62,500
Bisbee Special, Ariz					20	1:12,000
Bloodsworth Island, Md	38	00	76	00		1:62,500
Blue Mountain, N. Y	43	45	74	15	20	1:62,500
Bonner, Mont	46	30	113	30	100	1:125,000
Boonville, Ind	38	00	87	15	20	1:62,500
Boston, Mass. [a]	42	15	71	00	20	1:62,500
Boston Bay, Mass. [a]	42	15	70	45	20	1:62,500
Bradshaw Mountains, Ariz	34	00	112	00	100	1:125,000
Briggsville, Wis	43	30	89	30	20	1:62,500
Browning, Mont	48	30	113	00	100	1:125,000
Burnet, Tex. [a]	30	30	98	00	25	1:125,000
Calabasas, Cal	34	00	118	30	50	1:62,500
Camden, Ark	33	30	92	30	50	1:125,000
Camulos, Cal	34	00	118	30	100	1:125,000
Canandaigua, N. Y	42	45	77	15	20	1:62,500
Canton, Ohio	40	45	81	15	20	1:62,500
Castine, Me	44	15	68	45	20	1:62,500
Cerro Alto, Tex	31	30	105	30	50	1:125,000
Clarksburg, W. Va	39	15	80	15	20	1:62,500
Clayton, N. Y	44	00	76	00	20	1:62,500
Clifton, Ariz	33	00	109	15	100	1:62,500
Coalville, Utah	40	30	111	00	100	1:125,000
Coeur d'Alene Special, Idaho-Mont. [b]					50	1:62,500
Coopers Lake, Mont	47	00	112	30	100	1:125,000
Cortland, N. Y	42	30	76	00	20	1:62,500
Crisfield, Md.-Va	37	45	75	45		1:62,500
Dahlonega, Ga.-N. C. [a]	34	30	83	30	100	1:125,000
Deal Island, Md	38	00	75	45	10	1:62,500
Degonia Springs, Ind	38	00	87	00	20	1:62,500
Ditney, Ind	38	00	87	00	20	1:125,000
Edina, Mo	40	00	92	00	20	1:125,000

[a] Resurvey. [b] Double sheet.

GROUP I.—*Topographic atlas sheets and other maps engraved and published or in press during the fiscal year 1902–3*—Continued.

Quadrangle and State.	Position of SE. corner.				Contour interval.	Scale.
	Latitude.		Longitude.			
	°	′	°	′	*Feet.*	
Encampment Special, Colo. and Wyo					100	1:90,000
Fairmont, W. Va	39	15	80	00	20	1:62,500
Fairoaks, Cal	38	30	121	15	10	1:62,500
Fort McKinney, Wyo	44	00	106	30	100	1:125,000
Fostoria, Ohio	41	00	83	15	10	1:62,500
Gainesville, Ind. T.-Tex	33	30	97	00	50	1:125,000
Gothenburg, Nebr	40	30	100	00	20	1:125,000
Grindstone, N. Y	44	15	76	00	20	1:62,500
Guyandot, W. Va.-Ohio	38	15	82	15	20	1:62,500
Hammondsport, N. Y	42	15	77	00	20	1:62,500
Haubstadt, Ind	38	00	87	30	20	1:62,500
Helena, Mont.[a]	46	00	112	00	200	1:250,000
Kahoka, Mo.-Iowa-Ill	40	00	91	30	20	1:125,000
Kenly, N. C	35	30	78	00	20	1:62,500
Kenova, Ky.-W. Va.-Ohio	38	00	82	30	100	1:125,000
Kinderhook, N. Y	42	15	73	30	20	1:62,500
Luzerne, N. Y	43	15	73	45	20	1:62,500
Marathon Special, Wis	44	45	87	45	20	1:125,000
Mettawee, N. Y	43	00	73	00	40	1:125,000
Milton, W. Va	38	15	82	00	20	1:62,500
Mineral Point, Wis.-Ill	42	30	90	00	20	1:125,000
Nanticoke, Md	38	15	75	45	10	1:62,500
Naples, N. Y	42	30	77	15	20	1:62,500
Newburg, N. Y	41	30	74	00	20	1:62,500
New Harmony, Ind	38	00	87	45	20	1:62,500
Northport, N. Y	40	45	73	15	20	1:62,500
Norwich, N. Y	42	30	75	30	20	1:62,500
Oberlin, Ohio	41	15	82	00	10	1:62,500
O'Fallon, Mo.-Ill	38	30	90	30	50	1:125,000
Orono, Me	44	45	68	30	20	1:62,500
Owego, N. Y	42	00	76	15	20	1:62,500
Park City Special, Utah					50	1:25,000
Parmele, N. C	35	45	77	15	10	1:62,500
Penn Yan, N. Y	42	30	77	00	20	1:62,500
Petersburg, Ind	38	15	87	15	20	1:62,500
Phelps, N. Y	42	45	77	00	20	1:62,500
Phœnicia, N. Y	42	00	74	15	20	1:62,500

[a] Reengraved.

GROUP I.—*Topographic atlas sheets and other maps engraved and published or in press during the fiscal year 1902–3*—Continued.

Quadrangle and State.	Position of SE. corner.				Contour interval.	Scale.
	Latitude.		Longitude.			
	°	′	°	′	*Feet.*	
Princeton, Ind	38	15	87	30	20	1:62,500
Put-in-Bay, Ohio	41	30	82	45	10	1:62,500
Randsburg, Cal	35	15	117	30	50	1:62,500
Raquette Lake, N. Y	43	45	74	30	20	1:62,500
Rathdrum, Idaho	47	30	116	30	100	1:125,000
Richfield Springs, N. Y	42	45	74	45	20	1:62,500
Rock Creek, Cal	34	15	117	45	50	1:62,500
St. Meinrad, Ind	38	00	86	45	20	1:62,500
San Antonio, Cal	34	15	117	30	50	1:62,500
San Gorgonio, Cal	34	00	116	30	100	1:125,000
Santa Susana, Cal	34	15	118	30	50	1:62,500
Snoqualmie, Wash	47	00	121	00	100	1:125,000
Sullivan, Mo	38	00	91	00	50	1:125,000
Tarboro, N. C	35	45	77	30	10	1:62,500
Tejon, Cal	34	30	118	30	100	1:125,000
Tell City, Ky.-Ind	37	45	86	45	20	1:62,500
Terlingua Special, Tex					25	1:50,000
Theresa, N. Y	44	00	75	45	20	1:62,500
Velpen, Ind	38	15	87	00	20	1:62,500
Wausau Special, Wis	44	45	89	15	20	1:125,000
Waverly, N. Y	42	00	76	30	20	1:62,500
Weedsport, N. Y	43	00	76	30	20	1:62,500
Weeping Water, Nebr	40	30	96	00	20	1:125,000
Wetumka, Ala	32	30	86	00	50	1:125,000
Wheeling, W. Va.-Ohio-Pa	40	00	80	30	20	1:62,500
Williamston, N. C	35	45	77	00	10	1:62,500
Winthrop, Iowa	42	00	91	30	20	1:125,000

Résumé by States.

Alabama	1	Indian Territory	1
Arizona	4	Iowa	2
Arkansas	1	Kentucky	2
California	9	Maine	3
Colorado	1	Maryland	4
Georgia	1	Massachusetts	2
Idaho	2	Missouri	4
Illinois	3	Montana	6
Indiana	10	Nebraska	2

Résumé by States—Continued.

New York	25	West Virginia	6
North Carolina	5	Wisconsin	4
Ohio	8	Wyoming	3
Pennsylvania	1		
Texas	4	Total	118
Utah	2	Deducting for sheets counted in more than one State	17
Virginia	1		
Washington	1	Balance	101

GROUP II.—*Topographic atlas sheets and other maps in process of engraving, 1902–3.*

Bar Harbor, Me.
Bastrop, Tex. (resurvey).
Beaver, Pa.
Bellevue, Ohio.
Berne, N. Y.
Bowling Green, Ohio.
Cadiz, Ohio.
Chiwaukum, Wash.
Cleveland, Ohio.
Cuyamaca, Cal.
Deer Isle, Me.
Delaware, Ohio.
Dublin, Ohio.
Elmore, Ohio.
Euclid, Ohio.
Fairfax, Iowa.
Findlay, Ohio.
Fremont, Ohio.
Gilboa, N. Y.
Gloversville, N. Y.
Goleta, Cal.
Hayden Peak, Utah-Wyo.
Hueneme, Cal.
Jamul, Cal.
La Jolla, Cal.
Lassellsville, N. Y.
Massillon, Ohio.
Mount Desert, Me.
Mount Pinos, Cal.
Nashville, Tenn.
Newbern, N. C.
Patoka, Ind.-Ill.
Petit Manan, Me.
Ramona, Cal.
Rapid, S. Dak. (resurvey)
Republic, Wash
Rosendale, N. Y.
Sandusky, Ohio.
Santa Barbara, Cal.
Santa Paula, Cal.
Saypo, Mont.
Swan Island, Me.
Ventura, Cal.
Vermilion, Ohio.
Waukon, Wis.
Waynesburg, Pa.
West Chester, Pa.-Del.
Wooster, Ohio.

GROUP III.—*New topographic atlas sheets awaiting editorial examination before approval for engraving, 1902–3.*

Amity, Pa.
Ann Arbor, Mich.
Annapolis, Md.[a]
Anson, Me.
Apalachin, N. Y.
Assinniboine, Mont.
Ayden, N. C.
Baltimore, Md.[a]
Barnesboro, Pa.
Batavia, N. Y.
Berea, Ohio.
Binghamton, N. Y.
Blacksville, W. Va.-Pa.
Bluehill, Me.
Boonville, N. Y.
Boulder, Colo.
Brandon, Vt.
Bruceton, W. Va.-Pa.
Caledonia, N. Y.
Cameron, W. Va.-Pa.-Ohio.
Carlisle, Pa.
Carthage, N. Y.

[a] Resurvey.

GROUP III.—*New topographic atlas sheets, etc., 1902–3*—Continued.

Chautauqua, N. Y.
Cherryfield, Me.
Chickasha, Ind. T.–Okla.
Chief Mountain, Mont.
Chinook, Mont.
Columbia, S. C.
Copake, N. Y.
Coventry, N. Y.
Curwensville, Pa.
East San Antonio, Tex.
Ebensburg, Pa.
Edenton, N. C.
Elders Ridge, Pa.
Eldon, Mo.
Gravois Mills, Mo.
Falkland, N. C.
Fire Island, N. Y.
Greene, N. Y.
Grimesland, N. C.
Harford, N. Y.
Hartford, Wis.
Havre, Mont.
Hobart, N. Y.
Hollidaysburg, Pa.
Honeoye, N. Y.
Huntingdon, Pa.
Indio Special, Cal.
Iola, Kans.[a]
Juneau Special, Alaska.
Kaiser, Cal.
Kaweah, Cal.
Lancaster, Pa.
Llano, Tex.[a]
Long Lake, N. Y.
Margaretville, N. Y.
Marietta, Ohio–W. Va.
Mount Aix, Wash.
Mount Carmel, Ill.–Ind.
Needles Special, Cal.–Ariz.
Newcastle, Pa.
Niwot, Colo.
North Point, Md.[a]
Osoyoos, Wash.
Ouray, Colo.
Ovando, Mont.
Oxford, Md.
Palmyra, Mo.
Parkersburg, W. Va.–Ohio.
Patton, Pa.
Philippi, W. Va.
Pitcher, N. Y.
Port Washington, Wis.[a]
Richmondville, N. Y.
Riddles, Oreg.
Roan Mountain, Tenn.–N. C.[a]
Rocky Mount, N. C.
Rural Valley, Pa.
St. Michaels, Md.
San Diego, Cal.
Santanoni, N. Y.
Santa Ynez, Cal.
Saranac Lake, N. Y.
Scio, Ohio.
Setauket, N. Y.
Sharps Island, Md.[a]
Siloam Springs, Ind. T.–Ark.
Skykomish, Wash.
Southern California, Sheet No. 2.
Springhope, N. C.
Stehekin, Wash.
Steubenville, Ohio–W. Va.–Pa.
Terlingua, Tex.
Tonopah Mining Map, Nev.
Trent River, N. C.
Vadis, W. Va.
Vanceboro, N. C.
Vinalhaven, Me.
Wahpeton, N. Dak.
Wayland, N. Y.
Wellsville, Ohio–W. Va.–Pa.
West Bend, Wis.
Westerville, Ohio.
Weston, W. Va.
Wilson, N. C.
Winterville, N. C.
Yantic, Mont.

The progress in the publication of maps on the scale of 1:125,000 by the reduction and combination of those originally published on the scale of 1:62,500 is shown in the following table:

[a] Resurvey.

Progress in publication of maps on scale of 1:125,000 by reduction and combination.

Name of sheet, scale 1:125,000.	Names of sheets, scale 1:62,500, reduced and combined.	Stage of progress in publication.
Holyoke, Mass.-Conn	Chesterfield, Granville, Northampton, Springfield.	Published previous to July, 1898.
Nomini, Md.-Va	Leonardtown, Montross, Piney Point, Wicomico.	Do.
Housatonic, Mass.-Conn.-N. Y.	Becket, Pittsfield, Sandisfield, Sheffield.	Published during fiscal year 1898-99.
Niagara, N. Y	Lockport, Niagara Falls, Olcott, Tonawanda, Wilson.	Do.
Patuxent, Md.-D. C	Brandywine, East Washington, Owensville, Prince Frederick.	Do.
Raritan, N. J	Hackettstown, Highbridge, Lake Hopatcong, Somerville.	Published during fiscal 1899-1900.
Passaic, N. J.-N. Y	Morristown, Paterson, Plainfield, Staten Island.	Do.
San Luis, Cal	Arroyo Grande, Cayucos, Port Harford, San Luis Obispo.	Do.
Camden, N. J.-Pa.-Del	Chester, Glassboro, Philadelphia, Salem.	Published during fiscal year 1900-1901.
Rancocas, N. J	Hammonton, Mount Holly, Mullica, Pemberton.	Do.
Taconic, N. Y.-Mass.-Vt.	Bennington, Greylock, Berlin, Hoosick.	Do.
Navesink, N. J.-N. Y	New Brunswick, Asbury Park, Cassville, Sandy Hook.	Published during fiscal year 1901-2.
Mettawee, N. Y.-Vt	Fort Ann, Pawlet, Cambridge, Equinox.	Published during fiscal year 1902-3.
Ditney, Ind	Petersburg, Velpen, Boonville, Degonia Springs.	Do.
Patoka, Ind.-Ill	Mount Carmel, Princeton, New Harmony, Haubstadt.	In process of engraving.

Following is a list of 19 atlas sheets, heretofore published, which were revised and corrected, and of which new editions were published during the year or which were in press at the end of the year:

Atlas sheets revised, corrected, and new editions printed or in press, 1902-3.

Ausable, N. Y.
Bucksport, Me.
Cranberry, N. C.-Tenn.
Crater Lake Special, Oreg.
Cucamonga, Cal.
Downey, Cal.
Franklin Furnace, N. J.
Hempstead, N. Y.
Laramie, Wyo.
Lockport, N. Y.
Nantahala, N. C.-Tenn.
Niagara Falls and vicinity, N. Y.
Paterson, N. J.-N. Y.
Port Orford, Oreg.
Poughkeepsie, N. Y.
Ticonderoga, N. Y.
West Canada Lakes, N. Y.
Yellville, Ark.
Yosemite, Cal.

Corrections were also made on the following-named sheets:

Topographic sheets corrected during the fiscal year 1902–3.

Abington, Mass.
Batesville, Ark.
Beaver, Utah.
Blanco, Tex.
Bolton, N. Y.
Boston, Mass.
Boston Bay, Mass.
Brockport, N. Y.
Brownsville, Pa.
Buckhannon, W. Va.
Carmel, N. Y.–Conn.
Columbia, Tenn.
Connellsville, Pa.
Cornwall, Conn.–N. Y.
Cumberland Gap, Ky.–Va.–Tenn.
Dardanelle, Ark.
Dedham, Mass.
Donaldsonville, La.
Edgemont, S. Dak.–Nebr.
Elcajon, Cal.
Elizabethtown, N. Y.
Elkland, Pa.
Ellensburg, Wash.
Fayetteville, Ark.
Fort Hancock, Tex.
Framingham, Mass.
Franklin Furnace, N. J.
Gaines, Pa.
Geneva, Wis.
Glassboro, N. J.
Globe, Ariz.
Globe Special, Ariz.
Granbury, Tex.
Grundy, Ky.–Va.
Hackettstown, N. J.
Hamlin, N. Y.
Harpers Ferry, Md.–Va.–W. Va.
Harrisonville, Mo.
Highbridge, N. J.
Hill, Kans.
Huntington, Ohio–W. Va.
Idaho Basin, Idaho.
Indiana, Pa.
Kaibab, Ariz.
Lake Placid, N. Y.
Lassen Peak, Cal.
Lawrence, Mass.–N. H.
Little Falls, N. Y.
Magazine Mountain, Ark.
Marion, Iowa.
Mason, Tex.
McMinnville, Tenn.
Morganton, N. C.
Mount Holly, N. J.
Mount Ida, Ark.
Mount Stuart, Wash.
Mullica, N. J.
Nampa, Idaho.
Newcastle, Wyo.–S. Dak.
New Haven, Conn.
New Orleans, La.
Norwalk, Conn.
Oak Orchard, N. Y.
Oceana, Va.–W. Va.–Ky.
Old Forge, N. Y.
Ontario Beach, N. Y.
Orland, Me.
Oyster Bay, N. Y.
Plattsburg, N. Y.–Vt.
Portland, Me.
Prescott, Ariz.
Ramapo, N. Y.–N. J.
Ridgeway, N. Y.
Roby, Tex.
Rock Springs, Tex.
Romney, W. Va.–Va.
Rouse Point, N. Y.–Vt.
Salt Basin, Tex.
Salyersville, Ky.
San Carlos, Tex.
San Luis Rey, Cal.
Schuylerville, N. Y.
Seattle, Wash.
Sierraville, Cal.
Silver City, Idaho.
Silver Peak, Nev.–Cal.
Somerville, N. J.
Southern California, No. 1.
Staten Island, N. Y.–N. J.
Sundance, Wyo.–S. Dak.
Texas State map.
Tioga, Pa.
Tishomingo, Ind. T.
U. S. base map. (Small.)
U. S. base map. (9-sheet.)
Webster, Mass.–Conn.
Westfield, N. Y.

Topographic atlas sheets printed and the number of copies delivered during the fiscal year 1902–3.

Name of sheet.	Copies.	Name of sheet.	Copies.
Abington, Mass	2,070	Clarksburg, W. Va	2,590
Aladdin, Wyo	2,636	Clayton, N. Y	2,620
Alexandria Bay, N. Y	2,574	Clifton, Ariz	2,600
Ausable, N. Y	2,060	Coalville, Utah	3,150
Bangor, Me	2,585	Coeur d'Alene Special, Idaho	2,573
Baraboo, Wis	905	Colfax, Cal	2,589
Batesville, Ark	588	Coopers Lake, Mont	3,000
Bear Valley, Idaho	1,103	Cornwall, Conn.-N. Y	3,000
Beaver, Utah	1,095	Cortland, N. Y	2,604
Benton, Ark	603	Cranberry, N. C	2,614
Bisbee, Ariz	2,577	Crater Lake Special, Oreg	4,600
Bisbee Special, Ariz	2,332	Crisfield, Md	2,595
Blanco, Tex	1,000	Cucamonga, Cal	2,628
Bolton, N. Y	2,085	Cumberland Gap, Ky	2,105
Bonner, Mont	3,093	Dahlonega, Ga.-N. C	2,617
Bloodsworth Island, Md	2,622	Dallas, Tex	590
Boonville, Ind	2,608	Dardanelle, Ark	580
Boston, Mass	600	Deal Island, Md	3,052
Boston Bay, Mass	504	Dedham, Mass	2,130
Boyertown, Pa	2,599	Degonia Springs, Ind	2,604
Bradshaw Mountains, Ariz	2,612	Ditney, Ind	2,175
Briggsville, Wis	2,600	Donaldsonville, La	2,090
Broadalbin, N. Y	2,613	Downey, Cal	2,625
Brodhead, Wis	1,080	Edina, Mo	2,583
Brockport, N. Y	2,148	Encampment Special, Wyo	3,091
Brooklyn, N. Y	2,094	Estillville, Ky.-Tenn	2,121
Brownwood, Tex	575	Fairmont, W. Va	2,620
Buckhannon, W. Va	2,125	Fairoaks, Cal	2,554
Bucksport, Me	2,575	Fish Lake, Utah	1,012
Burnet, Tex	3,000	Fort Hancock, Tex	1,000
Calabasas, Cal	2,623	Fort McKinney, Wyo	3,000
Camden, Ark	2,550	Fort Worth, Tex	884
Canajoharie, N. Y	2,620	Fostoria, Ohio	3,000
Canandaigua, N. Y	2,578	Framingham, Mass	2,120
Capistrano, Cal	2,605	Franklin Furnace, N. J	2,547
Carmel, N. Y	2,105	Fremont, Nebr	1,109
Castine, Me	2,606	Gainesville, Ga	2,141
Catskill, N. Y	2,112	Gainesville, Ind. T.-Tex	2,605
Cerro Alto, Tex	3,000	Geneva, Wis	1,108
Chambersburg, Pa	2,500	Glassboro, N. J	2,100

Topographic atlas sheets printed and the number of copies delivered during the fiscal year 1902–3—Continued.

Name of sheet.	Copies.	Name of sheet.	Copies.
Gothenburg, Nebr	2,600	Mooers, N. Y	2,065
Granbury, Tex	1,000	Morganton, N. C	1,076
Grindstone, N. Y	2,586	Morgantown, W.Va.-Pa	2,581
Grundy, Va.-Ky	2,050	Morrisville, N. Y	2,640
Guyandot, W. Va.-Ohio	2,590	Mount Holly, N. J	2,101
Hackettstown, N. J	2,108	Mount Ida, Ark	606
Hamlin, N. Y	2,077	Mount Marcy, N. Y	2,638
Hammondsport, N. Y	2,589	Mullica, N. J	2,093
Harrisonville, Mo	2,120	Nantahala, N. C.-Tenn	2,565
Harpers Ferry, Va.-W. Va.-Md	2,060	Nanticoke, Md	3,000
		Naples, N. Y	2,629
Helena, Mont	2,580	New Harmony, Ind.-Ill	3,000
Hempstead, N. Y	2,605	New Haven, Conn	2,047
Highbridge, N. J	2,121	New Orleans, La	1,087
Hill, Kans	806	Niagara Falls, N. Y	3,522
Holbrook, Ariz	1,090	Norridgewock, Me	2,064
Huntsville, Ala	585	Norton, Kans	901
Huntington, W. Va	2,080	Norwalk, Conn	2,130
Idaho Basin, Idaho	896	Norwich, N. Y	2,613
Kahoka, Mo.-Iowa.-Ill	2,600	Oak Orchard, N. Y	2,115
Kaibab, Ariz	2,068	Oceana, W. Va.-Va.-Ky	2,070
Kenly, N. C	3,000	O'Fallon, Mo.-Ill	2,592
Kennebunk, Me	2,120	Old Forge, N. Y	2,101
Kenova, Ky.-W. Va.-Ohio	3,000	Ontario Beach, N. Y	2,074
Kinderhook, N. Y	2,577	Orland, Me	2,085
Laramie, Wyo	2,600	Orono, Me	2,590
Lassen Peak, Cal	1,543	Owego, N. Y	2,572
Lawrence, Mass	2,115	Oyster Bay, N. Y	2,627
Little Falls, N. Y	3,000	Paradise, Nev	593
Lockport, N. Y	2,595	Park City Special, Utah	3,111
Luzerne, N. Y	3,000	Parmele, N. C	2,632
McMinnville, Tenn	1,271	Paterson, N. J.-N. Y	2,613
Magazine Mountain, Ark	581	Pauls Valley, Ind. T	2,596
Marathon Special, Wis	2,620	Penn Yan, N. Y	2,678
Marion, Iowa	1,108	Peterboro, N. H	2,060
Mason, Tex	1,000	Petersburg, Ind	2,616
Mettawee, N. Y	2,593	Phelps, N. Y	2,593
Milton, W. Va	2,590	Plattsburg, N. Y	2,120
Mineral Point, Wis.-Ill	2,612	Portland, Me	2,095
Monroe, Ga	1,083	Port Orford, Oreg	2,546

Topographic atlas sheets printed and the number of copies delivered during the fiscal year 1902–3—Continued.

Name of sheet.	Copies.	Name of sheet.	Copies.
Port Washington, Wis	114	Somerville, N. J	2,112
Poughkeepsie, N. Y	2,602	Southern California, No. 1	2,611
Prescott, Ariz	620	Spanish Fort, La	1,048
Princeton, Ind	3,000	Staten Island, N. Y	2,128
Racine, Wis	1,116	Sullivan, Mo	2,600
Ramapo, N. J	2,120	Taylor, Tex	900
Randsburg, Cal	2,623	Tell City, Ky.-Ind	2,580
Rathdrum, Idaho	3,000	Terlingua Special, Tex	2,587
Richfield Springs, N. Y	2,616	Theresa, N. Y	2,595
Ridgeway, N. Y	2,108	Ticonderoga, N. Y	2,623
Roby, Tex	586	Velpen, Ind	2,610
Rock Creek, Cal	3,000	Wausau Special, Wis	2,612
Rock Springs, Tex	1,000	Waverly, N. Y	2,560
Romney, W. Va.-Va	2,122	Webster, Mass	2,145
Rouse Point, N. Y	2,103	Weedsport, N. Y	2,597
Rush Springs, Ind. T	2,615	Weeping Water, Nebr	2,553
St. George, Utah	615	Wernersville, Pa	2,642
St. Meinrad, Ind	2,600	Westfield, N. Y	2,117
Salt Basin, Tex	1,000	Wetumka, Ala	2,581
Salyersville, Ky	2,114	Wheeling, W. Va.-Ohio-Pa	2,600
San Carlos, Tex	1,000	Whitehall, N. Y	2,575
San Gorgonio, Cal	2,634	Williamston, N. C	2,632
Santa Susana, Cal	2,590	Willsboro, Vt	2,115
Schuylerville, N. Y	2,108	Winthrop, Iowa	2,639
Seattle, Wash	1,099	Yellville, Ark	3,000
Sierraville, Cal	2,128	Yosemite, Cal	3,050
Slatington, Pa	2,609		

Geologic folios completed and number of copies delivered during 1902–3.

No.	Name.	Edition.
80	Norfolk, Va. (double folio)	5,039
81	Chicago, Ill.-Ind. (quadruple folio)	6,090
82	Masontown-Uniontown, Pa. (double folio)	5,088
83	New York City, N. Y.-N. J. (quadruple folio)	6,037
84	Ditney, Ind	5,052
85	Oelrichs, S. Dak.-Nebr	5,059
86	Ellensburg, Wash	5,303
87	Camp Clarke, Nebr	5,093
88	Scotts Bluff, Nebr	5,099

Geologic folios completed and number of copies delivered during 1902-3—Continued.

No.	Name.	Edition.
89	Port Orford, Oreg	5,220
90	Cranberry, N. C.-Tenn	5,000
91	Hartville, Wyo	5,000
92	Gaines, Pa	5,000
93	Elkland-Tioga, Pa. (double folio)	5,000
		73,080

Geologic folios in press June 30, 1903.

Brownsville-Connellsville, Pa.
Columbia, Tenn.
Globe, Ariz.
Globe Special, Ariz.
Indiana, Pa.
Nampa, Idaho.
Newcastle, Wyo.
Olivet, S. Dak.
Parker, S. Dak.
San Luis, Cal.
Silver City, Idaho.
Tishomingo, Ind. T.

Miscellaneous matter printed during fiscal year 1902-3.

Item.	Number of copies.	Number of printings.
Indian Territory map	3,114	9,342
U. S. base map, 18 by 28	2,103	6,309
U. S. base map, 11 by 16	2,108	4,216
U. S. base map for Weather Bureau	5,500	11,000
U. S. relief map for Weather Bureau	5,500	49,500
U. S. rainfall map for Weather Bureau	885	10,620
Press bulletins	90,820	90,820
Index map circulars	65,463	294,592
Philippine Islands reports	155	155
Circular letters	14,500	14,500
Blank forms	4,050	4,050
Cross-section paper	1,000	1,000
Signal flags	1,000	1,000
Photolithographs on map paper	7,970	7,970
Photolithographs on drawing paper	8	8
Photolithographs on celluloid	237	237
Photolithographs on cloth	11	11
Special copies of maps on drawing paper	172	516
Special copies of maps on map paper	286	858
Special copies of maps on bond paper	49	147
Total	204,931	506,851

Totals derived from the foregoing tables.

Engraving of topographic atlas sheets:		
Sheets completed (counting double sheets two)		103
Sheets completed in part		48
Sheets corrected		115
Engraving of bases for geologic folios:		
Bases completed		19
Bases completed in part	Franklin Furnace Franklin Furnace Special Mount Stuart Edgemont Silver Peak	5
Printing:		Copies delivered.
Atlas sheets printed (212)		462,096
Geologic folios completed (14)		73,080
Miscellaneous printings (506,851)		204,931
Total printed sheets delivered		740,107

INSTRUMENT SHOP.

The instrument shop remained in the administrative charge of Mr. S. J. Kübel and its immediate supervision in charge of Mr. Ernest Kübel, mechanician. Repairs were made as follows:

Repairs of instruments in 1902–3.

Telescopic alidades	168
Wye (Y) levels	76
Transits	2
Box compasses	274
Declination compasses	36
Circular hand levels	34
Locke levels	12
Abney levels	10
Rod levels	7
Steel tape lines	45
Sight alidades	108
Pocket prismatic, and clinometer compasses	51
Plane-table board plates	159
Fitting shoes on traverse tripod legs	80
Johnson-movement tripods	113
Traverse tripods	86
Level tripods	69
Theodolite tripods	9
Transit tripods	6
Protractors	3
Aneroids	2
Heliotrope	1
Reflection mirrors	6
Dividers	8
Projection indicator	1

Repairs of instruments in 1902–3—Continued.

Hand counters	20
Turning pins (for precise work)	8
Microscopes	2
Slide rule	1
Field glass	1
Fitting sockets in plane-table boards	20
Standarize screws and sockets	500

Repairs of machinery and instruments for the engraving division also occupied considerable time.

Copperplate making and engraving.

	Number.
New plates made	344
Plates resurfaced and cut to small plates	15
Plates electrotyped, "bassos"	33
Plates electrotyped, "altos"	28

ADMINISTRATIVE BRANCH.

Executive Division.

Work not otherwise assigned, such as that pertaining to appointments, correspondence, and distribution of Survey documents, remained under the general charge of the chief clerk, Col. H. C. Rizer, who was assisted by Mr. A. F. Dunnington, in charge of correspondence and records, property, stationery, handling of mails, etc.; by Mr. W. D. Wirt, in charge of documents; by Mr. S. A. Aplin, topographer, as custodian of instruments, in charge of purchase and repair of instruments, and custodian of topographic records, and by such other persons as were needed.

CORRESPONDENCE AND RECORDS, SUPPLIES, AND SHIPMENTS.

The miscellaneous office work remained in charge of Mr. A. F. Dunnington during the year, assisted by Mr. W. F. Morsell, appointment and correspondence clerk; Mr. J. E. Allen, property clerk, assisted by Mr. J. P. Hendley; Mr. Paul M. Bryan, mail clerk (vice Mr. J. C. Gawler, transferred to hydrographic division); Mr. A. B. Anderson, registered mail, express, and freight clerk; Miss Laura E. Thorwarth (vice Miss Marian Thorwarth, transferred to geologic branch), file clerk, assisted by Mrs. E. V. M. Clarke; Mr. C. T. Bright, stationery clerk

(vice Mr. A. C. Cosdon, transferred to editorial division); Mr. A. G. McChesney and Miss H. S. Cook, property clerks.

During the year 62,266 letters were received, recorded, and referred (including 11,754 money letters, containing $10,756.17).

The appointment business increased last year over 100 per cent. A large part of the time of the appointment and attendance clerk was required for general letter writing and for the answering of questions touching the construction of the civil-service rules and departmental practice relating to appointments, attendance, etc.

The appointment records show the following changes for the year: Original appointments made by the Secretary of the Interior, 366; reinstatements, 6; extensions, 48; reappointments, 47; changes of official designation, basis of pay, etc., 14; promotions, 164; reductions, 2; total, 647. Of separations there were 81, of which 9 were dismissals, expirations of limited appointments, etc., 39 were resignations and transfers to other branches of service, 10 were deaths, and 29 were declinations or revocations of appointments. Aggregate changes of all kinds during the year, 728. Like the work connected with appointments, that relating to attendance has expanded with the growth of the Survey. No estimate is given of the number of applications for annual leave and brief absences recorded and disposed of during the year, but more than 350 sick leave applications and applications for leave without pay were handled, 65 being of the latter kind.

The number of printing requisitions drawn on the Department was 553; stationery requisitions on the Department, 296; office stationery requisitions received and filled, 5,884.

Authorities requested of and obtained from the Department of the Interior for open-market material, supplies, etc., amounted to $122,793.86, embracing 449 authorizations requested of and granted by the Department; requisitions on the Department for supplies, 434; orders

drawn for open-market supplies, 2,376; office requisitions received and filled, 2,908; bills checked for settlement, 2,311. The office property returns are up to date.

Of the express and freight, 2,668 pieces were received and 2,934 pieces were shipped—a total of 5,602 pieces. Accounts checked for the above, 254. Within the year the office issued a bill of lading of its own, covering shipments formerly made through quartermasters and on ordinary bills of lading, and the experiment has proved satisfactory. Registered mail received, 1,994 pieces; shipped, 50,758—a total of 52,752 pieces.

The general increase in the work of this section is due in large part to new work, growing out of the addition to the Bureau of the reclamation service.

DOCUMENTS.

This section remained in charge of Mr. W. D. Wirt, who was assisted by Messrs. H. E. Crook, H. W. Meredith, J. P. Benfer, J. R. Walsh, W. J. Yaste, and J. W. Green, Miss M. E. Mullen, and Messrs. W. C. Douglas, W. R. Ennis, Michael Giusta, J. S. Donohue, and W. D. Vaughan. Mr. Ennis and Mr. Giusta died while employed as wrappers.

The publications received were: Twenty-second Annual Report, Parts I, II, III, IV, with separates from Parts III and IV; Twenty-third Annual Report; Monographs XLI to XLIV; Professional Papers Nos. 1 to 10; Bulletins Nos. 191, 194 to 207, 209, 210, 213; Water-Supply and Irrigation Papers Nos. 59, 60, 65 to 78; Mineral Resources of the United States, 1901, and separates therefrom; some of the separates from Mineral Resources of the United States, 1902; four miscellaneous publications; geologic folios Nos. 80 to 91; and 215 topographic maps and atlas sheets, of which 117 are new and 98 are reprints, the combined editions of which number 469,422 sheets.

During the year 253,507 volumes, 43,182 folios, and 440,422 maps were sent out.

The correspondence handled in the division during the year comprised 90,672 letters received and 109,686 letters sent.

TOPOGRAPHIC RECORDS AND INSTRUMENTS.

Mr. S. A. Aplin, assisted by Mr. Powell P. Withers, continued in charge of topographic records and instruments. The original field notes of triangulation, topographic, and level parties consisted of about 2,100 books and plane-table sheets and about 650 pieces of miscellaneous material, all of which have been filed in accordance with the existing catalogue system. In addition, the material relating strictly to the various quadrangles surveyed was separately filed.

Repairs to instruments were made principally by Mr. Ernest Kübel, mechanician of the Survey, but owing to the limited time available in which to make the greater part of repairs, it was necessary to employ Mr. Godfred A. Hornig for two months to assist him.

Certain repairs which could be more economically handled by larger outside shops were made by Mr. G. N. Saegmüller, of Washington, D. C., and Messrs. W. and L. E. Gurley, of Troy, N. Y.

Owing to the increased operations of the Survey, and in order to replace instruments made defective by wear and tear, additions were made to the stock as follows: One precise level, 2 8-inch micrometer theodolites, 12 telescopic alidades, a number of Y levels, plane-table movements and boards, and the small accessories necessary to the equipment of the parties.

Disbursements and Accounts.

Mr. John D. McChesney, chief disbursing clerk, continued in charge of this division throughout the year. The law providing for the reclamation of the arid lands, approved June 17, 1902, caused a large increase in the duties devolving upon the division. This necessitated a slight addition to the clerical force. The gratifying state of efficiency of this division, noted in former reports, still prevails. A summarized statement of disbursements follows, and a detailed statement is preserved in the office.

FINANCIAL STATEMENT.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1903.

	Geological Survey, 1903.	Geological Survey, 1902 and 1903.	Geological maps of the United States, 1903.	Surveying forest reserves, 1903.	Total.
Appropriations: Acts approved Feb. 14, 1902; June 28, 1902, and March 3, 1903	$843,770.00	$60,000.00	$100,000.00	$130,000.00	$1,133,770.00
Amounts expended, classified as follows:					
Services	544,512.32	30,650.43	71,274.28	78,097.24	724,534.27
Traveling expenses	56,823.93	5,082.53	193.70	5,796.02	67,896.18
Field subsistence, supplies, and expenses	140,102.34	21,692.08		38,588.95	200,383.37
Instruments	12,609.78	336.72		2,290.45	15,236.95
Laboratory material	5,179.60				5,179.60
Photographic material	6,579.06	375.82		64.35	7,019.23
Books and maps	2,231.63				2,231.63
Stationery and drawing material	820.92	65.81		348.81	1,235.54
Illustrations for reports	179.20				179.20
Office supplies and repairs	8,853.27	345.45		397.60	9,596.32
Correspondence	660.47	17.90	9.93	83.08	771.38
Materials for engraving and printing maps			17,612.04		17,612.04
Railroad accounts settled at United States Treasury:					
Passenger	2,206.61	50.40		364.35	2,621.36
Freight	234.62	7.05		94.53	336.20
Total expenditures	780,993.75	58,624.19	89,089.95	126,125.38	1,054,833.27
Balance unexpended July 1, 1903	62,776.25	1,375.81	10,910.05	3,874.62	78,936.73
Probable amount required to meet outstanding liabilities	62,387.47	1,375.81	10,910.05	3,874.62	78,547.95

Analysis of disbursements.

Opposite the following heads appear the total expenditures under the various appropriations:

1. Salaries of scientific assistants	$29,573.96
2. Skilled laborers and various temporary employees	19,990.92
3. Topographic surveys	296,166.22
4. Geologic surveys	140,750.64
5. Paleontology	8,174.05
6. Chemical and physical researches	16,231.07
7. Preparation of illustrations	16,992.89
8. Mineral resources of the United States	49,780.17
9. Books for the library, etc	2,257.76
10. Gaging streams, etc	169,091.99
11. Geological maps of the United States	89,089.95
12. Mineral resources of Alaska	58,624.19
13. Salaries, office of Geological Survey	31,984.08
14. Surveying forest reserves	126,125.38
Total	1,054,833.27

The Library.

The library remained in charge of Mr. C. C. Darwin until December 16, 1902, at which time Mr. F. B. Weeks was appointed librarian and Mr. Darwin assistant librarian.

The librarian was assisted during the year by Miss Julia L. McCord, Miss M. E. Latimer, Mr. Thomas K. Gallaher, and Mr. J. E. Latimer, and during June by Miss Sara G. Hyde and Miss Ellen A. Hedrick.

Prior to his appointment as librarian Mr. Weeks spent considerable time in a study of methods employed in the Library of Congress and other libraries. As a result, a scheme for the rearrangement and classification of the Survey books on the shelves, by subject, was prepared, and questions relating to cataloguing and to changing from the large-size cards to those of standard size, now in use in most libraries, were satisfactorily determined.

During the year the library received and entered in the accession book 586 books obtained by purchase and 2,255 obtained by exchange and gift, making the total number of books now entered in the accession book 52,841.

Considerable time was spent in examining the various sets of periodicals and publications of scientific societies to determine what parts are lacking and in endeavoring

to secure the missing parts. As a result, 150 additions to these sets have already been received.

During the year 1,750 books were bound.

The manuscript of the annual bibliography and index of North American geology, etc., for 1902, was nearly completed by June 30, and will be published at an early date.

J. W. Powell

NECROLOGY.

JOHN WESLEY POWELL.

Maj. John Wesley Powell, the second Director of the United States Geological Survey, died at his summer home, Haven, on the Maine coast, September 23, 1902, leaving a wife and a daughter. He was born at Mount Morris, in western New York, March 24, 1834, and was therefore in his sixty-ninth year at the time of his death.

His father and mother, Joseph and Mary Dean Powell, came to America, from England, in 1830. After spending some time in New York City and in the village of Palmyra they went to Mount Morris, in Livingston County, N. Y., and there, on March 24, 1834, was born the fourth of their nine children, whom they named John Wesley. Joseph Powell, a man of strong character, was a licensed exhorter in the Methodist Episcopal Church, and his wife was well educated; the home, therefore, was a center of social life and religious influence. Both learned to love ardently the civil institutions of this country, but were strongly opposed to slavery; hence Joseph Powell left the Methodist Episcopal Church and joined the newly organized Wesleyan Methodist Church, in which he became a regularly ordained preacher. In 1838 or 1839 the family removed to Jackson, Ohio, and in 1846 continued westward to South Grove, Walworth County, Wis., where a farm was purchased. A few years later a larger farm was purchased at Bonus Prairie, Boone County, Ill., and thither the family moved in 1851.

The father's vocation necessitated his absence from home a large part of the time, and on the future explorer, while yet a boy, fell much of the management and work of the farm. His early schooling was such as rural com-

munities afford. Later he studied at Janesville, Wis., working mornings and evenings for his board. His parents impressed upon him the importance of obtaining a thorough education, and when—about 1853—the Wesleyan College was established at Wheaton, Ill., the family removed there in order that the children might have the educational advantages. The father became one of the trustees of the college, and John W., then about 19 years old, entered the preparatory classes. Here he devoted himself to study, with intervals of teaching and engaging in business avocations, until 1855, when, largely through the influence of the late Hon. John Davis, of Kansas, he entered the preparatory department of Illinois College, at Jacksonville, Illinois.

It was but natural that the parents should earnestly desire to see this promising son become a minister, and he as yet had no other aspiration; therefore, in order that he might enjoy a theological atmosphere, in 1857 he entered Oberlin College. Here he took up the study of botany, and though he had always been a close observer of natural phenomena it was this systematic study of plant life that turned him squarely toward science. Always enthusiastic, he organized the class into a club, which at once began to search the woods and swamps around Oberlin; thus he made an almost complete herbarium of the county. In the summer of 1858, having returned to Wheaton, he joined the Illinois State Natural History Society, which was making a natural history survey of the State through the voluntary labor of its members. The department of conchology was assigned to Powell, who made a fairly complete collection of the Mollusca of Illinois, as well as collections in botany and mineralogy. He traversed on foot, besides Illinois, portions of Wisconsin, Iowa, and Missouri; and he made, in a skiff, voyages on the Mississippi, the Ohio, and the Illinois rivers. At about this time he determined to devote his life to geology, and the next year was spent in study, teaching, and lecturing, usually on some geologic topic.

His school days were ended, but he remained a hard student all his life. In the summer of 1860 he became principal of the public schools of Hennepin, Ill. Into the work of organizing and improving these he entered with his accustomed vigor, but he continued to devote all his spare time to collecting botanical and zoological specimens.

A lecturing tour in the spring of 1860 had taken him into some of the Southern States, and he had become convinced that war was impending. The winter of 1860–61 therefore found him studying military science and engineering, and when the first call for troops came he was ready. His original enrollment, which occurred May 8, 1861, was as a private in Company H, Twentieth Illinois Infantry Volunteers. He was promoted to be sergeant-major May 14, and before his company was mustered into the United States service the governor of Illinois commissioned him to be a second lieutenant. As such he was mustered into service June 13, 1861, to serve three years. In the fall of 1861 he was detached from his command for duty on the fortifications at Cape Girardeau, Mo. He was practically given charge of planning and constructing the fortifications at that place, a work he executed so well that it received the unqualified commendation of General Fremont. While engaged in such duty he was authorized by General Grant, who referred to him as "an efficient officer of the Twentieth Illinois Volunteers who has been acting as engineer," to raise a company to manage the siege guns. On December 11, 1861, he was mustered into service as captain of Battery F, Second Illinois Light Artillery Volunteers, to serve three years. After a few weeks' drilling he was ordered to proceed with his battery to Pittsburg Landing, Tenn. On April 6, 1862, while in action with his company at Shiloh, he received a gunshot wound of the right arm, necessitating its amputation. This was performed so hastily and so imperfectly that a second amputation soon became imperative, which left a mere stump below the elbow joint; and from this he suffered considerable

pain for many years, until 1894, when a third operation brought relief.

On account of this wound he was absent from his command until sometime in the summer of 1862, when, by order of General Grant, he was placed on recruiting service; and he continued on such duty until March, 1863, when he returned to his battery. On November 1, 1863, he was assigned to duty as chief of the artillery of the fourth division, Seventeenth Army Corps. In February and March, 1864, he was with the expedition to Meridian, Miss. Early in April he was detached for the purpose of raising and organizing a regiment of colored troops, and he was in the performance of such duty until September 18, 1864, when he was announced as inspector of artillery for the Department and Army of the Tennessee. He served in that capacity or as commanding officer of the artillery brigade of the Seventeenth Army Corps from that date until near the end of the year. In all the operations after the fall of Atlanta he took an active part. When Sherman commenced the march to the sea, Powell was sent back, with his batteries, to General Thomas at Nashville, and at the battle of Nashville he served on that general's staff. On December 28, 1864, he was directed to proceed to Springfield, Ill., for the purpose of attending to the reorganization of his regiment. In a letter dated Springfield, Ill., January 4, 1865, he requested to be mustered out, to date from January 4, 1865. In the meantime he had been commissioned as major, Second Illinois Light Artillery Volunteers.

Says Frederick S. Dellenbaugh,[a] who was with Powell on his second expedition down the Colorado Canyon, in 1871-73:

> As a soldier his career was marked by a thorough study and mastery not only of the details of military life, but of military science. Especially was he apt in utilizing material at hand to accomplish his ends—a trait that was also prominent in his civil life. Bridges he built from cotton-gin houses, mantelets for his guns from gunny bags and old rope,

[a] The Romance of the Colorado River, pp. 376-380. G. P. Putnam's Sons, New York and London, The Knickerbocker Press. 1903.

and shields for his sharpshooters from the moldboards of old plows found on the abandoned plantations. All this time wherever possible he continued his studies in natural science. He made a collection of fossils unearthed in the trenches around Vicksburg, land and river shells from the Mississippi swamps, and a large collection of mosses while on detached duty in Illinois. He also familiarized himself with the geology of regions through which the armies passed to which he was attached. Time and again he was commended for his services and declined promotion to higher rank in other arms of the service. "He loved the scarlet facings of the artillery, and there was something in the ranking of batteries and the power of cannon," writes Thompson, "that was akin to the workings of his own mind."

In 1862 he was married to his cousin, Miss Emma Dean, of Detroit. Mrs. Powell was often his companion in the army and early Western journeys.

Upon the return of Powell to civil life in 1865 he was tendered a nomination to a lucrative political office in Dupage County, Ill., and at the same time he was offered the chair of geology in the Wesleyan University, a struggling Methodist college at Bloomington, Ill. There was no hesitation on his part. He declined the political honor and its emoluments and accepted the professorship, which he retained two years. At the session of the Illinois legislature in 1867 a bill was passed, largely through his effort, creating a professorship of geology and natural history in the State Normal University at Normal, Ill., with a salary of $1,500 and an appropriation of $1,000 annually to increase the geological and zoological collections. He was elected to this chair, and at about the same time was also chosen curator of the Illinois State Natural History Society, whose collections were domiciled in the museum of the normal university. Attracted by the Far West as a field for profitable scientific research, the summer of 1867 found him using his salary and the other available funds to defray the expense of an expedition to the then Territory of Colorado for the purpose of securing collections. He organized and outfitted at Plattsmouth, Nebr. All his assistants were volunteers except the cook. A. H. Thompson, afterwards so closely associated with him in the detailed exploration of the Colorado and in subsequent survey work, was the entomologist of the party. They crossed the plains with mule teams to Denver, worked along the east slope of the Front Range, climbed Pikes Peak, and went westerly as far as South Park. Without realizing it, apparently, Powell was all these years steadily approaching the great exploit of his life, as if led on and prepared by some unseen power. Now the project of exploring the mysterious gorges, of which he heard such wonderful tales, dawned upon him. It was as near an inspiration as can be imagined. Henceforth his mind and energy were directed irresistibly toward the accomplish-

ment of this conception. Again, in 1868, he was in the field with the same financial backing, to which was added a small allotment from the Illinois Industrial University at Champaign, Ill., a State school. All but Mrs. Powell and his brother Walter, of this 1868 party, returned East on the approach of autumn, while with these and several trappers and hunters, among whom were the two Howlands, William Dunn, and William Rhodes Hawkins, afterwards of his party to explore the canyons, he crossed the range to White River and wintered there near the camp of Chief Douglass and his band of Utes. When spring came, in 1869, he went out to Granger, on the Union Pacific Railway, and there disposed of his mules and outfit, proceeding immediately to Washington, where he induced Congress to pass a joint resolution, indorsed by General Grant, authorizing him to draw rations from Western army posts for a party of 12 men while engaged in making collections for public institutions. Never was assistance better deserved. Then he returned to Illinois and obtained from the trustees of the Normal University permission to again divert his salary and the other funds to Western work. The trustees of the Illinois Industrial University allotted him $500, and the Chicago Academy of Sciences, through the influence of Dr. Andrews, the curator, also contributed $250 or $500. In addition some personal friends contributed small sums.

The object proposed was to make collections in natural history, to be shared accordingly with the contributing institutions. While these collections were one of Powell's objects, others were the examination of the geology, and particularly the solution of the greatest remaining geographical problem of the United States, the canyons of the Green and Colorado rivers. The Green, as has been explained in preceding pages, was known as far as the Uinta Mountains, and here and there at widely separated points on down to about Gunnison Valley. But there were long gaps, and below Gunnison Crossing as far as the Grand Wash the knowledge of the canyons, as already pointed out, was vague in the extreme. The altitude of Green River station, Wyoming, was known to be about 6,000 feet above sea level, and that of the mouth of the Virgen less than 1,000. How the river made up this difference was not understood, and this problem was what Powell now confronted. His fortitude, nerve, courage, and war experience served him well in this endeavor, upon which he started, as previously described, in the spring of 1869.

This expedition met with so many disasters that Powell deemed a second descent in the interest of science desirable, and for a continuation of his explorations Congress voted in 1870 an appropriation of $10,000. This second expedition was successful, performing its work in the years 1871–72–73.

From 1871 until 1878 Congress continued to make appropriations for topographic and geologic surveys of the country adjacent to the Colorado River and its tributaries, and of the Rocky Mountain region generally, to be expended under the supervision of the Smithsonian Institution. But two other organizations—the Hayden and Wheeler surveys—were doing similar work in the Western Territories, and the fields and operations of the three overlapped. The resulting rivalry threatened the Congressional appropriations. An attempt at mutual agreement failing, at Powell's suggestion Congress called on the National Academy of Sciences for advice. A committee of the academy made a study of the subject, and reported a plan which had been formulated and advocated by Powell. That plan involved the abolition of the rival organizations and the creation of separate bureaus for the topographic, geologic, and ethnologic surveys of the western part of the United States, and it was finally adopted by Congress, except that no provision was made for an independent topographic corps.

The new United States Geological Survey was created by act of Congress approved March 3, 1879, and was made a bureau in the Department of the Interior. With Powell's hearty support, Clarence King was made the first director, and when, after a brief incumbency, Mr. King retired, Major Powell was immediately made his successor. This occurred in the spring of 1881.

In his first report as Director, Major Powell wrote as follows concerning the plans and work of his predecessor:

> Coming to the work from a long and successful experience, Mr. King elaborated a comprehensive plan of operations and vigorously prosecuted the same through the assistance of a wisely selected corps of geologists and specialists. It would have been fortunate if this work could have been completed and published under his administration. As it was, no change was made in the plan of operations or methods of investigation. To complete what he had begun was the proper course.

The Geological Survey was well established under King, and during the thirteen years of Powell's directorate its growth was remarkable. Its field, which was at first practically restricted to the Far West, was soon enlarged so as to include the entire area of the United States. The annual appropriation was gradually increased, and from time to time new functions were added, the most important being that of investigating the broader problems of water supply and irrigation. As the magnitude of the work increased, the organization of the corps was readjusted. With a moderate allotment of funds and the limitation of work to a region sparsely inhabited, King had found it advantageous to establish a number of independent districts, each under direction of a chief of division who had charge of topographic as well as geologic work. With a larger field and a much larger allotment of funds, Powell effected a reorganization under which each chief of division was put in charge of a particular kind of work and had for his field the entire country. The necessity for a topographic base map on which to delineate the geologic formations led early to the apportionment of a relatively large share of the funds to geographic work, and the topographic maps were found to have so many uses in addition to those of the Geological Survey that this policy was continued. Thus one of the great geographic services of the world was developed as a part of the Geological Survey. Provision for other branches of scientific work was made by the establishment of a division of chemistry and physics, a division of paleontology, and, eventually, a division of hydrography; and much attention was given also to the organization of divisions with operative functions auxiliary to the scientific work, such as the library, the division of engraving, and the division of accounts. The efficiency of the Bureau is largely due to Powell's ability as an organizer and his skill in the selection of men. Impaired health led to his resignation in 1894.

Of Powell's work in geology his associate and friend, Mr. G. K. Gilbert, has written[a] as follows:

This period was one of rapid development of geologic work in the United States, and the administration of the national work was at least an important factor in that development. The field of the national survey was early enlarged so as to include the whole country, and fears were entertained lest a diminution of State work should result; but the State work expanded along with the national, and through measures of cooperation each strengthened the other. Though official publication was varied and voluminous, it did not fully keep pace with the growth of geologic activity, and the surplus output was so large as to warrant the institution of two geologic journals and an annual volume of geologic transactions.

Powell's work in geology included observation, classification, explanation, and application to welfare.

His work as an observer began in early manhood, while he was a teacher and afterwards a college professor. It ranged through various departments of zoology and botany as well as geology and paleontology, and was carried on in the Mississippi Valley, on the Great Plains, and in the Rocky Mountains. It gave him a wide familiarity with the phenomena of nature, and was of great educational value, but it made no printed record. Afterwards he made systematic surveys of the geology of two western districts, one traversed by the Green River and the other by the Colorado, and the results of these surveys were committed to writing and given to the public.

In the second division of geologic work his chief contributions are three in number—a classification of mountains, a classification of processes of land sculpture, and a classification of stream valleys. While these classifications were not founded on principles of causation, and can not therefore be assumed to be final, it is proper to say that each one was characterized by originality, marking a distinct advance on previous classifications; each one has had a distinct influence on the trend of geologic thought; and the elements of each, after nearly three decades of phenomenal development of the science, are to be found in all modern text-books of geology.

His contributions to explanatory geology pertain likewise to mountains, land sculpture, and stream valleys. He advanced a general hypothesis as to the cause of those local upliftings of the earth's crust which make continents and mountains. He announced the fundamental principles of control in the sculpture of the land, crystallizing his central idea in the new term *base-level*. He introduced a group of explanations of the relations of waterways to mountains and ridges,

[a] Proc. Washington Acad. Sci., vol. 4, 1903, pp. 113–117.

accompanying the new ideas with three new terms—*consequent valleys*, *antecedent valleys*, and *superimposed valleys*.

None of these contributions to geologic philosophy was elaborated or adequately illustrated; his presentation gave no suggestion of the breadth of the inductions on which they were founded. It was his belief that a scientific fact needed no argument, but only statement. The fruits of his study were cast forth as simple seeds, to germinate or perish, according to their worthiness or unworthiness, or as the accident of their environment might determine. The theory of mountain growth, the last of the group to be announced, rests as he left it, and has not yet demonstrated its vitality by growth. But the ideas embodied in *base-level*, *consequent*, *antecedent*, and *superimposed* fell on fertile ground, and have had a marvelous development. A half score of younger men have elaborated, extended, and applied them; and they stand to-day for a division of the science so important that it is sometimes called the "new geology." Geologists and geographers now recognize that each hill, hollow, and plain of the earth's surface originated by some process of change, and is therefore susceptible of explanation and interpretation. Whereas geologic history was formerly read in the rocks alone, it is now read not only in the rocks but in the forms of the land and the arrangement of the streams.

Powell's contribution to applied geology involved much more than the utilization of geologic knowledge. He dealt with the complex problem of the subjugation to human use of the arid portion of our national domain, and he brought to bear on it the scientific data of climatology and sociology as well as geology. His "Lands of the Arid Region," published nearly twenty-four years ago, set forth with marvelous insight the conditions by which the problem is surrounded, and formulated the principles by which much of the later work has been guided. It was discredited at the time, because it announced that only a small per cent of the Far West can ever be reclaimed for agriculture. It roused a storm of indignation, because it characterized as semi-arid the middle belt of the plains, toward which settlement was then tending. But to-day it is recognized as the classic treatise on the subject, the great initial discussion which marked out the lines for future investigation and indicated the evils to be remedied by future legislation. It began a great agitation, in which Powell took a leading part for many years. At his suggestion Congress appointed a commission to study the physical and economic conditions of the arid region, with a view to the modification or reconstruction of its land laws, and he gave two years to the work of this commission. Afterwards, as Director of the Geological Survey, he was charged with the measurement of the streams, the survey of reservoir sites, and other researches looking to the conservation of the water supply for the broadest development of irrigation in the region of meager

rainfall. And his interest continued unabated after his retirement from the directorship had relieved him of responsibility. The economic problems were complicated by conflicting interests; the effort for reform was a disheartening struggle, with many failures and reverses; and the end is not yet; but it is a matter of congratulation, as well as of poetic justice, that during his last sickness Powell was able to know of the passage of the Reclamation Act—the most important triumph of the arid lands agitation.

It was through Powell's personality that he accomplished much of his work for science. Gathering about him the ablest men he could secure, he was yet always the intellectual leader, and few of his colleagues could withstand the influence of his master mind. Phenomenally fertile in ideas, he was absolutely free in their communication, with the result that many of his suggestions—a number which never can be known—were unconsciously appropriated by his associates and incorporated in their published results. I have elsewhere expressed the opinion that the scientific product which he directly and indirectly inspired may equal or even exceed that which stands in his own name.

As a successful student of the structure of the Uinta Mountains and Colorado Plateaus, Powell holds an honorable position in the large and honorable company of geologic surveyors. As a frontiersman in a new territory of geologic thought he takes high rank among the leaders of the science—albeit of a science in which he labored for but half his active life. As an organizer, as a promoter of research by others, as an educator of men already highly trained, he has made all who profit by good geologic work his debtors. As an original, far-seeing, and patriotic advocate of an enlightened policy for the reclamation and highest utilization of our arid domain, he is entitled to the gratitude of the nation.

Starting in early years with the study of inanimate nature and the lower forms of life, Powell passed on to the study of man himself and all his activities. His exploratory work in the West brought him into contact with the Indians, and the ethnologic investigations thus begun led him into the broad field of anthropology, especially the departments of sociology, psychology, and philosophy. Concerning this department of his work Gilbert has said:[a]

Work on American ethnology had previously been discursive, unorganized, and to a large extent dilettante. He gave to it definite purposes conformable to high scientific standards, and personally trained

[a] Science, new series, vol. 16, 1902, pp. 564–565.

its corps of investigators. To men who had previously interested themselves in the study of Indians he gave new methods and a new point of view, and he succeeded in diverting to ethnology men already trained in scientific method by work in other fields of research. He realized, as perhaps few had realized before him, that the point of view of the savage is essentially different from that of the civilized man, that just as his music can not be recorded in the notation of civilized music, just as his words can not be written with the English alphabet, so the structure of his language transcends the formulæ of Aryan grammars, and his philosophy and social organization follow lines unknown to the European. He also realized most fully that the savage is the embryo of the man of highest culture, and that the study of savagery is therefore a fundamental contribution to the broadest study of humanity. With these ideas he informed his ethnologic corps, and in consequence of them the organization of the bureau marks the most important epoch in American ethnology.

The same personal influence extended to the work of the Anthropological Society of Washington. Over the proceedings of this society Powell presided for many years, taking part in all its discussions and making it his special function to point out the bearing and relation of each communication to the greater problems and broader aspects of the science. As the bureau was and is a laboratory of ethnology, devoted to the study and record of the character and culture of the fading tribes of North America, so the society, including the same group of students, was and is an arena for the discussion of the broader science of anthropology. I but echo the general sentiment of those students in saying that the high intellectual and scientific plane on which the work of this society is conducted is a result, direct and cumulative, of Powell's influence and example. * * *

In much of his scientific writing Powell's style is terse to a fault. Usually he is satisfied with the simplest statement of his conclusions. Sometimes he adds illustrations. Only rarely does he explain them by setting forth their premises. It has thus happened that some of his earlier work, though eventually recognized as of high importance, was at first either not appreciated or misunderstood. The value of his anthropologic philosophy, though now widely appreciated, was recognized but slowly outside the sphere of his personal influence. His philosophic writings belong to a field in which thought has ever found language inadequate, and are for the present, so far as may be judged from the reviews of "Truth and Error," largely misunderstood.

To the nation he is known as an intrepid explorer, to a wide public as a conspicuous and cogent advocate of reform in the laws affecting the development of the arid West, to geologists as a pioneer in a new province of interpretation and the chief organizer of a great engine of research, to anthropologists as a leader in philosophic thought and the founder, in America, of the new régime.

Of Powell's contributions to the science of man his friend and associate for many years in the Geological Survey and the Bureau of American Ethnology, Mr. W J McGee, has written[a] as follows:

The first epoch in the growth of definite knowledge was that of the physical, or exact, sciences; the second was that of the natural sciences; and these were followed by a third—in some respects an echo of the second—in which the human sciences took shape. During this epoch the experiences of decades were summed, rather than those of generations or centuries as in earlier times; and the experiences were especially those of the variables of nature found in human conduct. The students were of the explorers and pioneer settlers pushing out over new lands inhabited by alien peoples, especially the continents of the Western Hemisphere. These soon learned from stress of contact that the really essential characters of alien races are not those of structure or stature or skin color, but those of habitual conduct; and as the quickened experiences pressed, the more thoughtful of the pioneers were led to classify the aborigines by their actions and dispositions, with little regard for their physical characters. This was the germ of a rejuvenated ethnology, i. e., a science of races based on human rather than animal attributes; and it was an easy step thence to the definition of tribes by their special habits of thought and the speech in which these were expressed. Although this third epoch in the history of science began a generation or two before Powell, he arose in time to give it character; he became the chief prophet of the doctrine of the differences between human and other animals, just as Linné and Huxley and Darwin were the leading apostles of the similarities of all animate nature; he stood almost alone in seeikng to raise the humanities—or the human activities, to use his own term—to the plane of scientific research; and while he gave less thought than some deemed needful to the physical characters of man, he strove unceasingly to harmonize the new ethnology with the philosophies of the earlier epochs, and thereby to erect a comprehensive anthropology broad enough to touch every human ideal and passion and law and motive, as well as the physical structures of the human body and brain. The anthropology of to-day is the science of the realm of self-conscious activity, and Powell was its chief creator.

In defining Powell's career as an anthropologist, it is to be remembered that he began a naturalist and developed as a geologist, so that he brought to the study of men a rich store of knowledge of nature as well as a strong grasp of the scientific method. Especially notable among his possessions was a principle brought over from geology—the principle of interpreting natural phenomena in terms of agency,

[a] Proc. Washington Acad. Sci., vol. 4, 1903, pp. 120–126.

or primary force, primary so far, at least, as current knowledge goes. This principle was perhaps the keynote of Powell's work in geology; certainly it became the keynote of his researches in ethnology and general anthropology.

Now, the third epoch in science, or that of the new ethnology to which Powell gave character, opened slowly, and, curiously enough, largely through the efforts of statesmen rather than of scientists. The actual pioneer of the new era was, indeed, inspired by the practical problems of statecraft; this was Albert Gallatin, who classified the American tribes known early in the last century by their languages, grouped them in linguistic families or stocks, and indicated their distribution on a map, the forerunner of Powell's map of Indian linguistic families of North America north of Mexico. It is somewhat singular that prevailing opinion, even in scientific circles, should credit Powell with originating that work in Indian linguistics, in which he was a follower rather than a leader; and this despite the fact that he constantly gave due credit to the eminent statesman in both public and private utterances. The next notable pioneer of the new epoch was Lewis H. Morgan, who sought to classify the American tribes on the basis of their law as expressed in terms of relationship. This masterly work, published in a noble volume by the Smithsonian Institution, forms one of the earliest and most trustworthy foundations for the science of sociology. The next great contribution to the new ethnology was a joint product, the chief contributors being Brinton in this country and Tylor in England; they sought a basis for defining and classifying the peoples of the world in their myths and beliefs. Meantime the handiwork of prehistoric and other primitive folk was made known through numerous investigators; while physical anthropology was well advanced, especially in Europe. Such, in brief, was the state of the science before Powell, though it is not to be forgotten that his career overlapped that of Morgan and of Brinton, as well as that of Tylor, the sole survivor of the series of pioneers.

In his earlier explorations Powell concerned himself first with the handiwork of the natives and afterwards with their myths; and almost from the beginning his vigorous mind grasped the great fact that both kinds of products, just like those of the processes of geology, are best interpreted in terms of agency, the agency in this case being human thought. Thence his studies extended to the social organization of the tribes—to the law of kinship, to loves and hates, to mating and family life—and then to esthetic concepts and on to the elaborate observances of ceremonial life; and he mastered the languages, first as a means of gathering facts and later for their own inherent interest. Throughout he found the same fundamental principle to apply; each new observation only confirming the truth that human actions are best interpreted in terms of mental power. An early outcome of the work

was a definition of the human activities as a basis for scientific research; and here Powell was able to combine, and thus to raise to higher planes, the admirable work of the pioneers already gone before, as well as that of his contemporaries. Then Gallatin's philology, Morgan's sociology, and the mythology (or sophiology) of Tylor and Brinton fell into orderly relation, while from his new height Powell was able to outline the fields of technology and esthetology and thus to define the entire domain of the actual humanities.

As his studies progressed, Powell saw that primitive and more advanced men do not think alike—that their minds respond differently to similar stimuli; and he soon perceived that the thought of the lowly man of woodland or water side is more dependent on surroundings than is that of the vigorous scion of a race trained to conquest over nature through many generations. Thus he came to realize that relation between mind and environment which led to his most comprehensive and important generalization, i. e., that of the great stages of human progress. These stages may be definded in various ways—by progress in social organization or law, by progress in industries, by progress in language, by progress in the arts, or by progress in philosophies; yet in the last analysis they express grades of intelligence, and hence correspond closely, howsoever defined. As originally outlined the stages are (1) savagery, in which the social unit is the clan, and the organization is based on kinship traced in the maternal line; (2) barbarism, in which the units are the gens and tribe, while the organization is based on kinship traced in the paternal line; and (3) civilization, in which the unit is first the city and later the nation, and in which the organization is territorial—to which may be added (4) enlightenment, in which the units are the individual and the state, while the law rests on equality of individual rights. Mankind may be classified in terms of these developmental stages no less definitely than by skin color and other physical attributes, and there is every promise that the classification of the world's peoples by culture grade will become increasingly important as inter-racial contacts multiply. It was in these broader generalizations that Powell especially profited by the genius of such great predecessors of the earlier epochs as Aristotle and Bacon.

When a knowledge maker has given form and substance to a great science; when he has shaped an epoch in the development of human knowledge; when by the vigor and extent of his work he has raised himself to the first place among the scientists of his generation, and when, withal, he has constantly fostered every scientific activity of his land, and has performed public administrative duties in science of unequaled magnitude, his work is not easily summarized within the space of a few minutes. The published details of Powell's work fill volumes; yet in ethnology and general anthropology, no less than in geology, the larger share of the fruit of his vigorous thinking was

turned over freely to colaborers, with a generosity unparalleled in the history of science, to find its way into the general body of human knowledge under other names than his own.

So brief an outline as this admits no more than the baldest mention of Powell's greatest contributions to the science of man: the recognition of agency in the human realm; the identification of that agency with the progressively growing mentality of the generations of men; the definition of the human activities as the basis of sciences of a new order; the recognition of the culture stages as waymarks of progress in the past and as guides for further advancement, and, toward the end of his labors, the recognition of mind itself as the sublimest product of natural interactions—these are among Powell's greatest gifts to the world. And it may not be forgotten that while these and other contributions grew out of patient research by the rigorous methods of science, they were warmed by a personal humanity of unsurpassed richness and sweetness, for Powell loved mankind with all the ardor of a great heart.

As Major Powell's most intimate scientific friend for years, it may be permitted me—nay, it behooves me—to say a word of his uncompleted work as well as of his duties done. As many know, it was the ambition of his life to build up a great bureau of the science of man, no less beneficent than the bureau of the science of the earth which he did so much to create—to establish a bureau of ethnology no less firmly and broadly than the Geological Survey was established; but here fortune failed him. * * *

Another ambition long glowed brightly in the Major's mind; it was that of summing all knowledge and philosophies, from those of savage and lower barbarian up to Plato and Aristotle, thence to Bacon and Linné, and on to the third epoch of science, to which he was so rich a contributor, in an organon or system, of three parts. The first of these was to deal with nature, i. e., the external universe; the second with man, the highest product of nature; and the third with mind, the ultimate natural power of nature and man. The work was directed toward general human understanding rather than conventional forms and current lines of thought, and was cast in the form of a trilogy, with an explement in poetic form and measure; and with a view to general and hence permanent character, both structure and form were modeled after artistic rather than technical standards. In giving shape to the triune work the Major delved deeply in lore and literature of every type, sifted through the meshes of his own broad knowledge the golden product of science in every branch, studied the mental workings of contemporaries and even of associates as he had studied those of savages before, and sought to sum the whole under simple allegorical titles. The breadth of the plan and the depth of its foundations were little realized by coworkers, still less by critics of

the preliminary essays; indeed, the modesty of the author seldom permitted him to see in its full magnitude the mighty task to which he was impelled by the same powerful instinct that inspired his military and exploratory efforts—the task of framing a cosmic compendium at once broader and simpler than any previously conceived. Of this work the first part was written in preliminary and far from satisfactory form, and was published under the title "Truth and Error;" much of the second part was tentatively incorporated in a series of papers in the American Anthropologist, designed for reprinting, with extensions, under the title "Good and Evil," while of the third part, designed to bear the title "Pleasure and Pain," only an outline, with notes, and a single preliminary chapter were completed. The poetic argument, or explement, although designed to round out the whole and perhaps to form a final volume, was in reality the first written and the most complete portion of the work, for it ran through the author's mind as a golden clew if not a more definite outline, and was put in finished form before the Major left the Geological Survey to undergo the third operation on his arm. Two or three copies of the manuscript are extant (including one in the cornerstone of the Gardiner Greene Hubbard memorial building[a]). The Major long had a plan for the completion of his organon in case he was cut off before it was done, but with characteristic optimism he failed to secure effective approval of the plan in writing, so that it may never be carried out.

Still, John Wesley Powell is not without monuments: The Ethnological Bureau, which he created and which he conducted for twenty-three years, * * * has long been regarded as a model by the ethnologists of every land; the four or five series of ethnologic publications under his name form a library of the science on which the anthropologists of the world are constantly dependent; his minor papers and addresses have done no less than the greater tomes to establish the science of man; yet his noblest monument, and the one which he would most appreciate, is that loving memory that lives in the hearts of his fellows in the study of humanity.

RICHARD URQUHART GOODE.

Mr. Richard Urquhart Goode was born in Bedford, Va., on December 8, 1858. His ancestors were among the more prominent of the early settlers of the United States, the family genealogy dating back to England. His father, Hon. John Goode, for a number of years represented Virginia in Congress, and during the first administration

[a] Southwest corner Sixteenth and M streets NW., Washington, D. C.

of President Cleveland he served with distinction as Solicitor-General. Richard Goode's mother was Sallie Urquhart, of Isle of Wight County, Va.

Mr. Goode's early education was completed at Hanover Academy, Norfolk, Va., after which he attended the University of Virginia for several terms. His first experience in engineering was acquired in 1877 and 1878 as assistant in the Engineer Corps of the Army. In 1879 he received an appointment from the Secretary of the Interior as topographer in the United States Geological Survey, and this appointment he retained until 1882. During that period he had charge of a party of surveyors engaged in extending topographic surveys through portions of Arizona, Utah, and New Mexico. In 1883, on the creation of the northern transcontinental survey, under the auspices of the Northern Pacific Railway, a large corps of geologists and topographers was engaged, under Raphael Pumpelly, in an exhaustive study of the natural resources of the region contiguous to the proposed line of railway. On this work Mr. Goode was employed as topographer during a portion of 1884, when he conducted extensive surveys in Montana, Washington, and elsewhere in the Northwest. In 1884, the United States Geological Survey being in urgent need of the services of skilled engineers, Mr. Goode was induced to return to work with this Bureau, and he remained with it until the time of his death, serving in various capacities from topographer to geographer in administrative charge of surveys in the western half of the country. In 1888 he was granted leave of absence in order that he might assist the engineers of the Panama Canal Company in important topographic and land surveys covering property rights on the Isthmus of Darien. His duties with that organization were those of engineer and astronomer.

During Mr. Goode's long and important connection with the topographic branch of this Bureau he had a varied experience in all of the more important work undertaken in the West and in a little of that done in the

East. In 1879 he conducted topographic surveys, under the direction of Mr. Sumner H. Bodfish, in Utah and Arizona. In 1880 he was assigned charge of the topographic work, under Capt. C. E. Dutton, in connection with surveys of the plateau region in the neighborhood of the Grand Canyon of the Colorado, in Arizona. In 1881 he reported to Prof. J. Howard Gore, in charge of the measurement of a base line from which to extend primary triangulation near Fort Wingate, N. Mex., on which work he was engaged until he temporarily severed his connection in 1882. On resuming employment in this Bureau in July, 1884, Mr. Goode was placed in supervisory charge of a group of parties engaged in surveys in Missouri and Kansas, and he continued on this work until 1886, when he was placed in charge of the section of topographic surveys in Texas. This assignment continued until 1889, except for the interruption caused by his trip to Panama in 1888 and a detail for a few months in 1887 to extend primary triangulation in Massachusetts. In April, 1889, he was transferred to charge of the southern central division of topography, including all work in the States of Mississippi, Louisiana, Arkansas, Indian Territory, and Texas, at which time he was promoted to geographer. In September, 1890, on the reorganization of the topographic branch into two principal divisions, eastern and western, he was transferred to the western branch, under the general direction of Prof. A. H. Thompson, and placed in charge of the Kansas-Texas division, which assignment he retained until August, 1894, when he was transferred to the more important charge of the Pacific section, comprising all the field work in the States of Idaho, Washington, Oregon, and California. On the reorganization of the topographic branch incidental to the retirement of Mr. Henry Gannett from charge of the topographic work Mr. Goode was assigned charge of one of the four sections into which the branch was divided, the Pacific section, which included all of the United States west of the Rocky Mountains. His

management of that important work, to which were later added surveys in Alaska and forest-reserve boundary surveys, gave eminent satisfaction during the next seven years. Early in June, 1903, the four topographic sections were consolidated into two, and Mr. Goode was placed in charge of the western section, including all the States west of the Mississippi Valley, approximately all of the United States west of the one-hundredth meridian.

The large amount of administrative work which devolved upon him as a result of these added duties and a generally run-down physical condition rendered Mr. Goode incapable of resisting an attack of pneumonia, which caused his death suddenly on Tuesday, June 9, 1903, at Rockville, Md., where he had temporarily made his summer home.

Mr. Goode was a member of the Washington Academy of Sciences and of the National Geographic Society, and was an officer and prominent member of the Cosmos Club. For several years past he had been a vestryman of St. Margaret's Church.

In 1889 Mr. Goode was married to Sophie J. Parks, of Norfolk, Va., who survives him with three children, the eldest about 13 and the youngest 9 years of age.

By the death of Richard Goode this Bureau has lost a skillful engineer, an able executive, and a valued adviser, while the Government has lost a faithful servant. At all times and under all circumstances he acted with courtesy and tact, yet with the necessary vigor, and by reason of his long experience in connection with the topographic work of the Government his services had become almost invaluable.

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